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1990

AIR QUALITY DATA SUMMARY
REGIONAL MUNICIPALITY OF
HAMILTON-WENTWORTH

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1990 AIR QUALITY DATA SUMMARY REGIONAL MUNICIPALITY OF HAMILTON-WENTWORTH

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1. SUMMARY

Airborne particulates (dust) and odours have been Hamilton's main air pollution problems in recent years. In 1990, particulate levels, namely dustfall, continued to show the improvements observed since 1987. Suspended particulate levels decreased by 20% from 1989. Odours due to reduced sulphur compounds have also reduced dramatically since 1987. Further improvements are still necessary as dustfall still remained well above objectives in the industrial zone, and odours continued to occur, especially in the Beach Blvd. area.

The Air Pollution Index reached the advisory level of 32 two times in 1990 compared to three times in 1989. The Air Quality Index showed that ozone and suspended particles were the pollutants of greatest concern, reaching the moderate range of the new index most frequently of the six measured pollutants.

The network of fluoride monitors continued a steady decline in concentrations, but levels near Hamilton Brick were well above objectives, sufficient to cause vegetation damage near the plant. The company is undertaking an abatement program to reduce their fluoride emissions.

Gaseous pollutants showed little change in 1990. Ozone is one of two gases which continued to exceed criteria. It is a product of long range transport and is produced photochemically to excess during the summer. Ozone reached the moderate range of the AQI from 19 to 61 hours at four Hamilton stations.

Total reduced sulphur concentrations have reduced dramatically in the city since 1987. The improvement appears directly related to Stelco Inc. replacing direct contact coolers in the coke oven by-products area with indirect coolers in April of

1987, and changes in slag quenching practices at Stelco and Dofasco. The only place where major improvement has not occurred is the Beach Blvd. area. Stelco's effect there was limited by distance. Hamilton's other steel company - Dofasco Ltd., and to a lesser extent the Carbochem tar plant, continued to impinge on the Beach.

Total reduced sulphur compounds are a cause of odours. Negotiations with industry for further reductions of these emissions are ongoing. Control programs or studies are under way at Stelco, Carbochem and Dofasco.

Airborne dust measurements near Steetley Industries, a limestone quarry in Flamborough, showed clear improvements in dustfall and suspended particulate levels following the installation of new electrostatic precipitators at the company's processing plant and various other efforts to control fugitive dust. However, suspended particulate measurements continued to show a localized problem with some measurements still above objectives.

2. INTRODUCTION

The Air Management Program in Ontario is based on controlling man-made emissions to meet ambient air quality objectives, which in turn are based on known effects on health, quality of life, sensitive vegetation or materials, whichever is most stringent. To achieve these objectives, sources of pollution are identified, their emissions evaluated and appropriate control measures are instituted. Ambient air monitoring is used to identify pollution sources and to verify that controls have been successful. Monitors are usually sited in areas suspected of experiencing higher levels of air pollution. When these areas achieve acceptable air quality, then it is assumed that other areas should also be acceptable.

3. MONITORING NETWORK

The Ministry of the Environment operates a network of ambient air monitors throughout Hamilton as shown in Figure 1 and Table 1. The network centres on six automated stations which continuously monitor a variety of pollutants and telemeter hourly averaged data to a central computer facility in Toronto. These stations are:

29000 - Elgin/Kelly, downtown

29025 - Barton/Sanford, between downtown and the industrial zone

29102 - Beach Blvd, normally downwind of the industrial zone

29105 - Nash/Kentley, in the east end

29114 - Vickers/East 18th, on the mountain

29118 - Main West/Highway 403, in the west end

The remainder of the network consists of numerous but less sophisticated monitors, some of which have been in existence since 1970. In addition to this regular network, special surveys are sometimes carried out to evaluate specific problems.

In June, 1988, the Ministry commenced broadcasting the new Air Quality Index across the Province. it is measured at over 30 locations in Ontario, including the downtown, east, west, and mountain stations in Hamilton. A description of the AQI and the 1990 results are presented in this report.

Meteorological data (wind speed, wind direction and air temperature) are observed at station 29026, (Woodward Avenue) located on the sewage treatment plant grounds. Figure 2 presents the wind frequency distribution measured and clearly indicates that winds from the southwest predominate.

The results of a computer program known as a "pollution rose" are included in this report. The program is essentially a cross-tabulation of hourly pollutant concentrations with wind direction. The data from this program are illustrated on various diagrams.

On each "rose", the length of each line is drawn proportional to the average concentration of a pollutant when the wind was blowing <u>from</u> that direction. The longest lines in the diagram usually point to a source or sources of the pollutant in question. The concentrations will be influenced both by the quantity of emissions and by meteorological conditions such as wind speed, etc.

From August 1 to mid-November 1990, Stelco Steel's Hilton Works was on strike, resulting in a shutdown of most of its operations. The effects of this strike on Hamilton air quality were previously studied in a separate report which appears as an appendix to this report.

TABLE 1
HAMILTON AIR MONITORING STATION LOCATIONS

Number	Location	AQI	SO_2	O_3	CO	NOx	TRS	COH	TSP	F	DF	Wind/ Temp
29000	Elgin/Kelly	x	x	x	x	x	x	x	x			
29001	Hughson/Hunter							x		x	x	
29006	Queenston/Craigroyston										x	
29009	Kenilworth/Roxborough								x		x	
29010	Burlington/Ottawa										x	
29011	Burlington/Leeds								x		x	
29012	Burlington/Wellington								x	x	x	
29017	Chatham/Frid								x		x	
29025	Barton/Sanford		x				x	x	x	x	x	
29026	Woodward/Brampton											x
29036	Roosevelt/Beach Rd.									x		
29044	Wark/Beach Boulevard										x	
29054	Beach Road/Conrad									x		
29059	Burlington/Gage									x		

AQI - Air Quality Index
SO_2 - sulphur dioxide
O_3 - ozone
CO - carbon monoxide
NOx - oxides of nitrogen
TRS - total reduced sulphur
COH - soiling index
TSP - total suspended particulates
DF - dustfall
F - fluoride

TABLE 1 (cont.)
HAMILTON AIR MONITORING STATION LOCATIONS

Number	Location	AQI	SO_2	O_3	CO	NOx	TRS	COH	TSP	F	DF	Wind/ Temp
29062	King E./Barons									x		
29066	Killarney/Beach Blvd.									x		
29067	Hughson N./Macaulay								x			
29082	Leaside/Knox										x	
29084	Rembe/Beach Blvd.										x	
29087	Cumberland/Prospect								x			
29098	Bay/Main West								x			
29102	Beach Blvd./Towers		x		x	x	x	x	x		x	
29105	Nash/Kentley	x	x	x				x	x			
29113	Gertrude/Depew								x			
29114	Vickers/East 18th	x	x	x		x	x	x	x			
29115	London/Justine									x		
29116	Dalkeith/Ottawa									x		

AQI - Air Quality Index
SO_2 - sulphur dioxide
O_3 - ozone
CO - carbon monoxide
NOx - oxides of nitrogen
TRS - total reduced sulphur
COH - soiling index
TSP - total suspended particulates
DF - dustfall
F - fluoride

TABLE 1 (cont.)
HAMILTON AIR MONITORING STATION LOCATIONS

Number	Location	AQI	SO_2	O_3	CO	NOx	TRS	COH	TSP	F	DF	Wind/ Temp
29118	Main W./Highway 403	x	x	x		x	x	x	x			
29119	Morley/Parkdale								x	x		
29120	Dickson/Burlington									x		
29122	Dundurn/York								x			
29124	Laurier/Columbia								x			
29126	Rosslyn/Montclair									x		
29127	Lawrence/Balmoral									x		
29129	Province/Justine									x		
29130	Ewen/Whitney								x			
29131	Central/Graham									x		
29135	Mt. Albion/Albright								x			
29136	Huntsville/Washington										x	
29217	Chatham/Fanning										x	
29230	Cameo Avenue										x	
29231	Audrey/East 27th										x	

AQI - Air Quality Index
SO_2 - sulphur dioxide
O_3 - ozone
CO - carbon monoxide
NOx - oxides of nitrogen
TRS - total reduced sulphur
COH - soiling index
TSP - total suspended particulates
DF - dustfall
F - fluoride

FIGURE 1

HAMILTON AIR MONITORING NETWORK

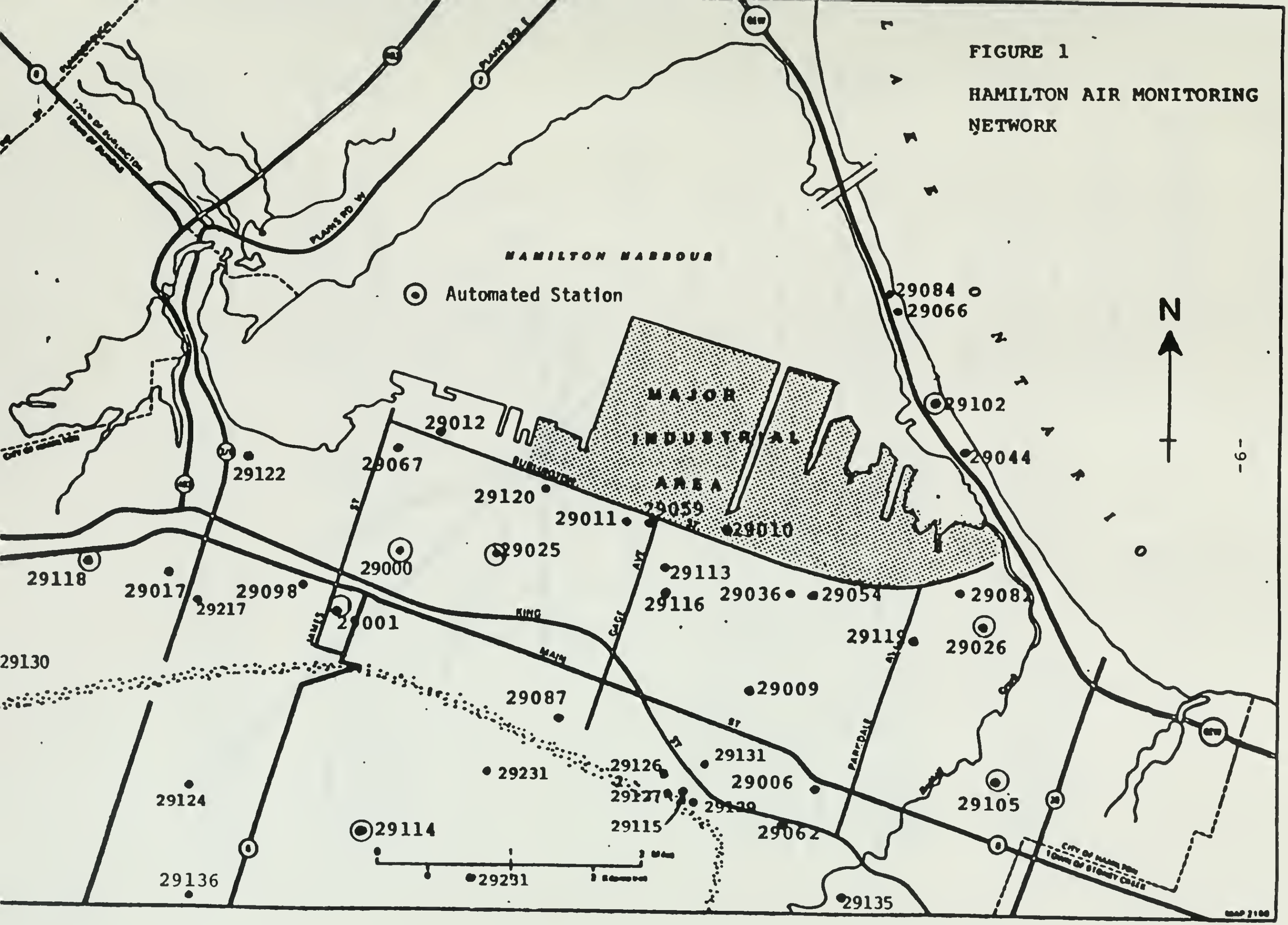
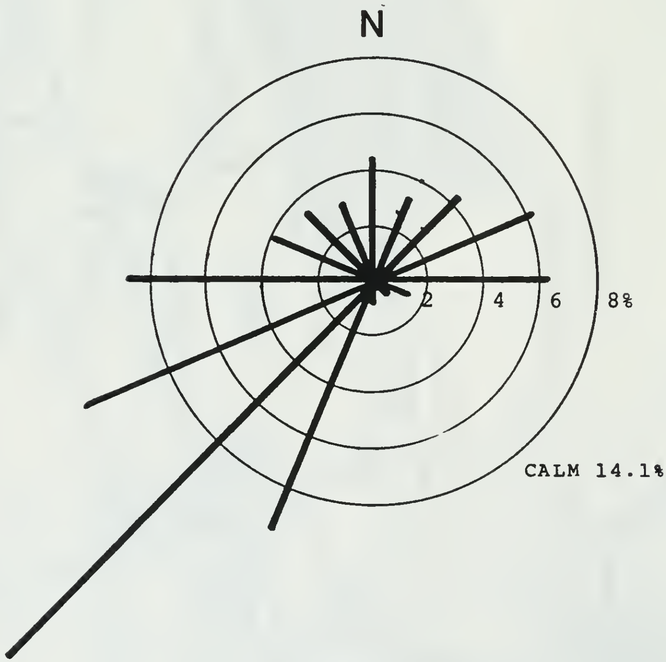


FIGURE 2

WIND FREQUENCY DISTRIBUTION

29026 - WOODWARD AVE

HAMILTON 1990



Lines indicate direction wind blew from

4. ANALYSIS OF DATA

4.1 Air Quality Index (AQI)

The AQI is a system by which the public can be informed about air quality on a daily and even hourly basis. The index supplemented the old Air Pollution Index (API) which had been in place since 1970 and which still exists as a subindex of the AQI.

In the AQI, hourly concentrations of sulphur dioxide, soiling index (airborne particles), nitrogen dioxide, carbon monoxide, ozone, and reduced sulphur compounds are all converted to a common scale of numbers. In addition to these hourly measurements, 8-hour average levels of carbon monoxide and the API, a 24-hour function of sulphur dioxide and particles are also included as subindices, making a total of 8 potential subindices measured every hour. The official AQI broadcast is the highest subindex at that time.

The AQI scale is classified as follows:

0 - 15	Very Good
16 - 31	Good
32 - 49	Moderate
50 - 99	Poor
100+	Very Poor

Index levels up to 31 should have little or no effect on people and the environment. Beginning at the moderate level, effects such as odour, vegetation damage and some health effects to sensitive individuals start to occur.

In the poor and very poor categories, these symptoms become more and more acute, such that virtually all people would be hampered in the very poor range.

When moderate levels or higher are measured, public health advisories can be issued to the public along with the actual index number.

The AQI started in June 1988, and statistics on hourly frequencies for 1990 in the five concentration categories for the four Hamilton stations are presented in Table 2.

As can be seen, ozone (O_3) and suspended particles (COH) were the most problematic pollutants. Figure 3a graphically displays the numbers of index hours in the Moderate or higher ranges for each station and for each sub-index. The downtown station can be seen to have recorded the most API, COH, and total reduced sulphur hours over 31. The mountain station recorded the most ozone hours. More details on these pollutants and others in the AQI will be discussed in this report.

It should be noted that this report refers to ozone occurring at ground level, where this substance acts as an irritant and is considered an unwanted pollutant. The report does not deal with the loss of naturally occurring stratospheric ozone in the upper atmosphere, which is a major concern.

Upper atmosphere ozone loss is monitored by Environment Canada. Environment Ontario has promulgated regulations to control the use and disposal of CFCs (chlorofluorocarbons) which cause upper atmospheric ozone loss.

TABLE 2
AIR QUALITY INDEX - 1990
HOURLY FREQUENCY DISTRIBUTION

		0 - 15 Very Good	16 - 31 Good	32 - 49 Moderate	50 - 99 Poor	100+ Very Poor
29000	SO_2	8666	0	0	0	0
Elgin/Kelly	COH	8138	433	72	1	0
Downtown	O_3	8176	382	19	0	0
	NO_2	8634	0	0	0	0
	CO 1 hr	8560	0	0	0	0
	CO 8 hr	8560	0	0	0	0
	TRS	8401	126	28	0	0
	API	7572	1034	55	0	0
29105	SO_2	8608	0	0	0	0
Nash/Kentley	COH	8358	217	18	0	0
East	O_3	8168	480	33	0	0
	API	8242	267	0	0	0
29114	SO_2	8685	0	0	0	0
Vickers/E 18th	COH	8426	176	28	0	0
Mountain	O_3	8025	617	61	0	0
	NO_2	8529	0	0	0	0
	TRS	7990	87	24	0	0
	API	8258	318	14	0	0
29118	SO_2	8716	0	0	0	0
Main West	COH	7962	478	60	0	0
West	O_3	8172	434	41	0	0
	NO_2	8579	0	0	0	0
	TRS	8374	138	16	0	0
	API	7724	877	7	0	0

4.2 Air Pollution Index

The Hamilton air pollution index (API) continued to be used as a warning system to alert the public to elevated air pollution levels and as a trigger for cutbacks in industrial emissions. It is derived from 24-hour average concentrations of sulphur dioxide and particulate matter. The combination of these two pollutants at elevated levels is indicative of detrimental human health effects. Hourly concentrations of both pollutants are telemetered to a central computer facility in Toronto which then calculates the index each hour, based on the following equations:

Downtown API = $1.47\ (16.4\ COH + 122.9\ SO_2)^{.92}$

East API = $2.68\ (11.0\ COH + 122.2\ SO_2)^{.79}$

West API = $2.84\ (10.8\ COH + 120.9\ SO_2)^{.77}$

Mountain API = $2.68\ (11.0\ COH + 122.2\ SO_2)^{.79}$

Where: COH is the 24-hour average soiling index concentration expressed in coefficient of haze units.

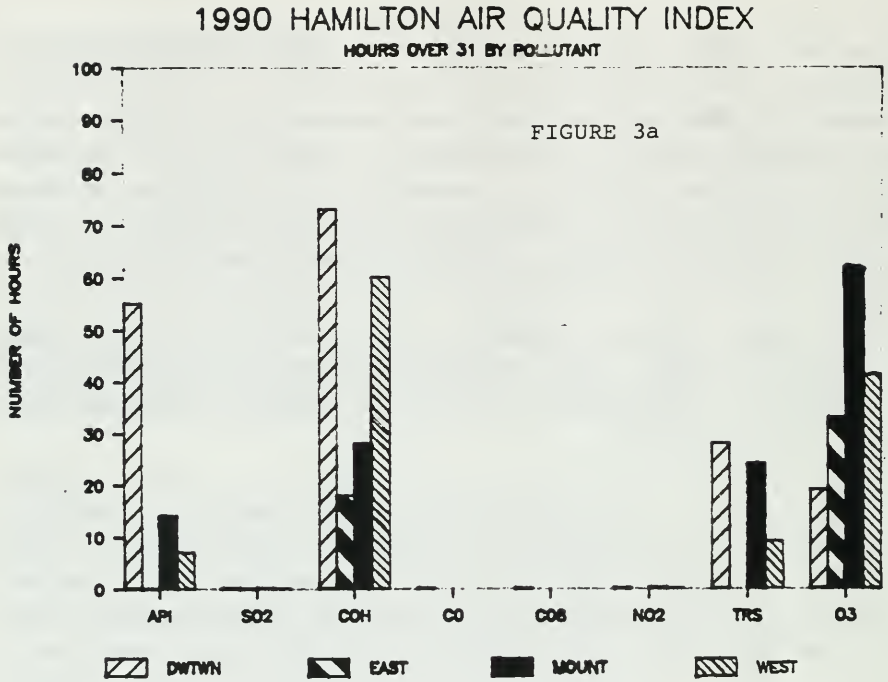
SO_2 is the 24-hour average of sulphur dioxide concentration expressed in parts per million.

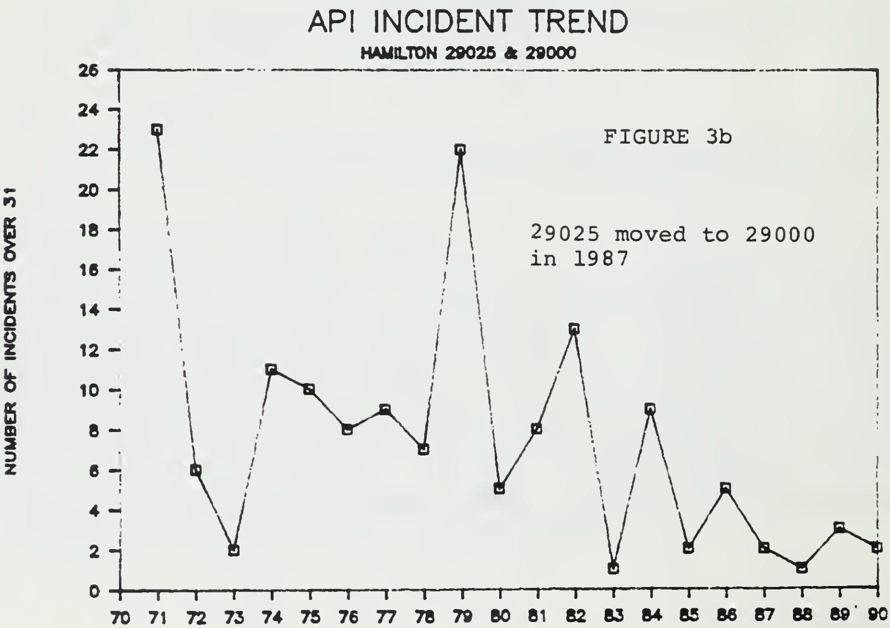
No action is taken for readings up to 31. At 32, known as the advisory level, and with a forecast of unfavourable dispersion conditions, major industries in Hamilton are notified and asked to voluntarily curtail certain operations. At an API of 50, cutbacks by these sources become mandatory. These levels are set with a considerable safety margin before health effects to sensitive people would be expected. At 75, further cutbacks would be ordered, and at 100 all sources not essential to public health and safety could be ordered to cease operations.

During 1990, there were two incidents in which the API reached or exceeded 32, both occurring during the spring. The first incident on March 15 caused the downtown, west and mountain stations to all simultaneously exceed 32. The second incident on April 28 caused only the downtown station to exceed 32 (the other two stations reached the mid-20's). The east end site recorded much lower levels during both incidents due to the northeast wind flow.

The incidents were a result of the classical lake breeze phenomenon, in which a warm southerly air mass was undercut by a cool northeast breeze off a cold Lake Ontario resulting in a temperature inversion.

There used to be a high variability in the numbers of incidents each year, a variability that was weather related, that is, the frequency of typical inversion conditions. However, there has been a general decline in the frequency of these incidents (Figure 3b) such that since 1984, one to five API incidents occur each year.


1990 HAMILTON AIR QUALITY INDEX
HOURS OVER 31 BY POLLUTANT
FIGURE 3a
NUMBER OF HOURS
100
90
80
70
60
50
40
30
20
10
0
API
SO2
COH
CO
COS
NO2
TRS
O3
DWTWN
EAST
MOUNT
WEST


API INCIDENT TREND
HAMILTON 29025 & 29000
FIGURE 3b
29025 moved to 29000
in 1987
NUMBER OF INCIDENTS OVER 31
26
24
22
20
18
16
14
12
10
8
6
4
2
0
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90

4.3 Particulates

There are three basic types of instruments employed for the measurement of particles, each type relating to a different size range:

a) Dustfall jars measuring heavy material, generally greater than 10 microns in diameter (one micron is one millionth of a metre).

b) High volume samplers measuring suspended particulates ranging in size from submicron to 50 microns.

c) Co-efficient of haze tape samplers measuring mostly fine material - from submicron to about 10 microns.

The ambient air quality objectives for suspended particulate are based on visibility effects. The dustfall objectives are based on nuisance effects while the soiling index objectives were derived from correlations with suspended particulate data.

4.3.1 Total Suspended Particulates

A high volume sampler draws a known volume of air through a pre-weighed filter for a 24 hour period (midnight to midnight). The exposed filter is weighed and the difference (weight of particulate matter on filter) in conjunction with the known air flow is expressed as a concentration of suspended particles in air of in micrograms per cubic meter. The objective for a 24-hour average is 120 ug/m^3 while the yearly geometric mean objective is 60 ug/m^3.

All 19 stations ran on a once every six day cycle, consistent with the practice in other North American jurisdictions. This means that each day of the week is sampled in sequence, i.e. Sunday, next Saturday, next Friday, etc. etc.

Suspended particulate data is summarized in Table 3a and shows a definite gradient of higher concentrations closer to the industrial area. Concentrations in 1990 were 20% lower than 1989 levels on average. While the Stelco strike may have played a small role in this decrease, the actual overall drop in suspended particulates due to the strike was very small.

The overall trend in TSP since 1970 is shown in Figure 4, which displays a levelling off in concentrations since 1977, although a slight downward trend over these years is still evident. The trend curve for industrial emissions also shows a slight downward slope over this period. While the trends of TSP and industrial emissions are similar, the magnitude of change is not. Emissions have decreased more than the TSP. TSP has not decreased as much as industrial emissions, probably because other pollution sources such as road dust, wind blown dust from unpaved areas, etc. contribute to TSP also.

Metals, Sulphate/Nitrate

The hi-vol filters were analyzed for seven metals, as well as sulphates and nitrates (Table 3b).

Concentrations of nickel, cadmium, lead and vanadium showed very low concentrations which did not vary appreciably throughout the city indicating that they were at background levels. The 24-hour criteria for these metals were easily met.

Concentrations of chromium showed a gradient with distance from the industrial area. However, even the highest levels were well below acceptable levels.

Iron and manganese concentrations were elevated and also showed a gradient with distance from the industrial area where concentrations were often well above general background levels, but usually below guideline values which are based on soiling and health effects respectively.

The sulphate/nitrate components measured at 5 stations comprised a large portion of the measured particulate matter. These constituents are largely by-products of major high temperature fuel combustion sources and can travel hundreds of miles from their source. The concentrations in Hamilton showed a small gradient from the industrial area in 1990, indicating some contribution from local industries. In past years, such a gradient was almost non-existent. Most of these acid aerosols are due to long range transport from distant sources. The sulphate/nitrate components are known to be a factor in reduced visibility and are often responsible for the widespread haze observed in Hamilton and surrounding areas during southerly winds.

It should be noted that the sulphate/nitrate analyses are subject to some error due to the measurement methodology. For this reason the data should be primarily used for evaluation of trends rather than use of the actual values. Alternative methodologies and filters are under investigation to improve the measurement technique. Tests with a new filter medium indicate that the glass fibre filter can cause as much as 8 ug/m^3 on average of spurious sulphate/nitrate formation from gaseous sulphur dioxide and nitrogen oxides. It is possible that the marginally higher industrial area sulphate levels are related to this error, since gaseous sulphur dioxide and nitrogen oxide levels are somewhat higher there.

Carbon

Hi-vol filters from four stations were analyzed for total carbon, elemental carbon and carbonate. Elemental carbon would include material such as coal, coke and kish, while total carbon would include numerous forms, both organic and inorganic in nature. Carbonate would include calcium carbonate (limestone) and dolomite. Sources of these carbonaceous materials would include coke ovens, blast furnaces, stockpiles, vehicle exhaust, biological materials and crushed stone (carbonate).

Data are given in Table 3c and show a distinct gradient in concentration with distance from the industrial area. Levels tend to be highest at 29011 (Burlington/Leeds) in the middle of the industries, followed by 29025 (Barton/Sanford) and 29102 (Beach Blvd.) on the fringes of the area followed by much lower levels at 29114 (Vickers/E 18th) on the mountain.

Suspended Particulates Analysis

A contour map of suspended particulate concentrations (yearly average) is given in Figure 5. It can be seen that the majority of the city met the yearly objective of 60 ug/m^3. Concentrations were only elevated close to the industrial area. It should be stressed that airborne particulate is not solely due to direct emissions from industrial sources. Dirty roadways and heavy truck traffic can also be contributors.

It should also be realized that these contour maps of concentrations are a very general picture of city wide air quality. Local influences affect some of the stations, and several more stations are required to fill in some gaps. Two small contours drawn in Figure 6 do not have strict scientific validity. They are drawn to indicate that particular station was subject to local sources such as traffic and wind blown dust, unrepresentative of overall patterns.

Figure 5 reflects long term average conditions. A different situation exists during inversion conditions, with poor dispersion, when pollution from all sources, including traffic and industry, can accumulate and will contribute to the totals.

Figure 6 depicts suspended particulate contours during an elevated Air Pollution Index incident on April 29, 1990. The 24 hour objective is 120 ug/m^3. The map displays increased pollution concentrations measured city-wide, diminishing with distance form the industrial complex. The contours are skewed toward the southwest reflecting the wind flow from the northeast. These increased concentrations are caused by lake breeze inversions which reduce the rate of dispersion from all sources within the city.

Most major sources in industry now have control technology in place, and the remaining sources are being abated. Stelco's D blast furnace cast house controls have been completed. Dofasco has completed a control program at the No. 1 melt shop. Stelco is in the process of upgrading controls on the sinter plant. Further upgrading of controls on the SWARU incinerator are planned. Slater Steel and Canada Pipe (formerly Canron) have completed upgrading of their particulate emission controls. Inside company properties, programs are in operation to control roadway sources of particulate. Roads have been paved and road cleaning is performed regularly. Better control of track-out to public streets still appears necessary, as well as improved cleaning of public streets. Landscaping of industrial properties has also been ongoing for some time in order to reduce wind blown dust. Further planting of vegetation wherever possible to provide ground cover and reduce wind speed at ground level should provide further improvements.

TABLE 3a
SUSPENDED PARTICULATES - 1990
UNITS - MICROGRAMS PER CUBIC METER
unless otherwise specified

Ontario Objectives: 24-hour - 120
1-year geometric mean - 60

LOCATION		Geometric Mean 1988	1989	1990	Maximum 1990	% of Samples > 120 (1990)
29000 -	Elgin/Kelly	68	75	64	209	11
29009 -	Kenilworth/Roxborough	49	62	54	176	6
29011 -	Burlington/Leeds	98	107	83	374	20
29012 -	Burlington/Wellington	56	65	52	155	3
29017 -	Chatham/Frid	80	95	66	200	11
29025 -	Barton/Sanford	81	80	69	221	6
29067 -	450 Hughson Street North	48	55	44	151	2
29087 -	Cumberland/Prospect	52	54	47	132	4
29098 -	Bay/Main	44	53	46	232	5
29102 -	Beach Boulevard	77	79	61	236	9
29105 -	Nash/Kentley	-	-	42	110	0

TABLE 3a - Continued
SUSPENDED PARTICULATES - 1990
UNITS - MICROGRAMS PER CUBIC METER
unless otherwise specified

Ontario Objectives: 24-hour - 120
1-year geometric mean - 60

LOCATION		Geometric Mean 1988	1989	1990	Maximum 1990	% of Samples > 120 (1990)
29113 -	Gertrude/Depew	81	100	73	246	9
29114 -	Vickers/East 18th	48	54	41	112	0
29118 -	Main West/Highway 403	43	51	41	162	4
29119 -	Morley/Parkdale	90	85	78	157	20
29122 -	Dundurn Castle	42	46	37	123	2
29124 -	Laurier/Columbia	33*	53	37	106	2
29130 -	Ewen/Whitney	39	33	31	136	2
29135 -	Mt. Albion/Albright	34	41	36	119	0

* Station moved to 29124 from 29128 in mid 1988.

TABLE 3b CONSTITUENTS IN SUSPENDED PARTICULATE (ug/m^3)

Station and Year	# of Samples	CADMIUM Geo. Mean	CADMIUM Max	CHROMIUM Geo. Mean	CHROMIUM Max	IRON Geo. Mean	IRON Max	LEAD Geo. Mean	LEAD Max	Manganese Geo. Mean	Manganese Max
4-hr. criterion		2.0		1.5		25.0 (Ferric Oxide)		5.0		2.5	
29001/29098 Hughson/Hunter + Bay/Main											
1987	55	.001	.012	.009	.04	1.5	13.1	0.1	0.4	.09	.68
1988	51	.000	.008	.006	.02	1.2	9.7	0.05	0.29	.06	.55
1989	60	.000	.004	.006	.08	1.2	7.2	0.04	0.42	.08	.90
1990	55	.000	.003	.007	.04	1.0	14.0	0.02	0.21	.07	1.15
29008/29102 Beach Blvd.											
1987	51	.001	.007	.012	.06	3.0	20.3	0.1	0.6	.19	1.40
1988	63	.001	.006	.012	.06	4.0	14.9	0.09	0.3	.27	.89
1989	59	.001	.006	.010	.06	2.6	16.0	0.06	0.24	.20	.73
1990	48	.000	.003	.009	.07	1.7	14.5	0.02	0.17	.14	.65
29011 Burlington/Leeds											
1987	57	.001	.007	.026	.12	5.1	32.5	0.2	0.4	.32	1.84
1988	52	.002	.017	.019	.13	5.4	21.4	0.18	0.84	.35	.91
1989	61	.001	.009	.025	.07	5.3	14.5	0.10	0.49	.35	1.14
1990	54	.001	.007	.020	.09	4.0	29.2	0.07	0.38	.26	1.20
29012 Burlington/ Wellington											
1987	57	.001	.009	.010	.03	1.4	10.5	0.1	0.3	.11	.81
1988	56	.001	.023	.006	.02	1.5	8.0	0.06	0.31	.10	.55
1989	60	.000	.004	.008	.15	1.5	5.4	0.05	0.27	.12	1.45
1990	57	.000	.002	.006	.04	1.2	8.3	0.02	0.15	.10	.52

29001 terminated at end of 1987

TABLE 3b CONSTITUENTS IN SUSPENDED PARTICULATE (ug/m^3)

:tation and Year	# of Samples	CADMIUM Geo. Mean	CADMIUM Max	CHROMIUM Geo. Mean	CHROMIUM Max	IRON Geo. Mean	IRON Max	LEAD Geo. Mean	LEAD Max	Manganese Geo. Mean	Manganese Max
4-hr. Criterion		2.0		1.5		25.0 (Ferric Oxide)		5.0		2.5	
:9017 :hatham/Frid											
.987	58	.000	.006	.009	.11	2.3	30.6	0.1	0.3	.12	.63
.988	54	.000	.004	.008	.03	2.2	7.4	0.06	0.52	.12	.43
.989	55	.000	.007	.010	.05	1.9	6.1	0.05	0.39	.13	.60
1990	56	.000	.002	.006	.04	1.3		0.01	0.18	.10	.56
:9025 3arton/Sanford											
1987	53	.001	.013	.013	.20	2.5	29.6	0.2	1.2	.17	5.29
1988	43	.001	.004	.013	.11	2.7	17.6	0.12	0.44	.17	.96
1989	59	.001	.008	.015	.07	2.4	16.1	0.09	1.56	.20	3.95
1990	52	.000	.004	.014	.68	2.2	17.8	0.03	0.16	.20	.78
29067 Iughson/Macauley											
1987	50	.001	.007	.012	.03	0.9	7.8	0.1	0.2	.06	.66
1988	54	.001	.005	.006	.02	1.2	7.2	0.06	0.19	.06	.43
1989	60	.000	.002	.007	.03	1.2	5.6	0.05	0.33	.09	.44
1990	52	.000	.001	.006	.07	0.6	7.2	0.02	0.12	.07	.50
29114 Vickers/East 18											
1987	55	.001	.007	.012	.06	1.1	22.1	0.1	0.5	.07	.90
1988	46	.000	.004	.006	.04	0.8	5.6	0.04	0.17	.04	.25
1989	56	.000	.003	.006	.05	1.0	7.7	0.04	0.27	.07	.50
1990	55	.000	.003	.007	.04	0.7	4.6	0.01	0.06	.05	.69

TABLE 3b CONSTITUENTS IN SUSPENDED PARTICULATE (ug/m^3)

tation and Year	# of Samples	NICKEL Geo. Mean	NICKEL Max.	VANADIUM Geo. Mean	VANADIUM Max.	NITRATE Geo. Mean	NITRATE Max.	SULPHATE Geo. Mean	SULPHATE Max.
4 hour riterion		2.0		2.0					
9001/29098 ughson/Hunter + ay/Main									
987	55	.004	.020	.01	.06	4.2	16.1	10.5	20.8
988	51	.006	.020	.01	.03	1.8	11.2	7.4	31.1
989	60	.005	.010	.01	.02	3.9	13.2	9.6	26.5
990	55	.005	.020	.01	.05	3.3	14.8	9.3	26.0
9008/29102 each Blvd.									
987	51	.006	.040	.01	.04	3.0	19.7	12.9	21.9
988	63	.007	.020	.01	.05	3.2	34.2	10.7	33.7
989	59	.006	.024	.01	.05	4.3	10.8	12.1	31.1
990	48	.006	.020	.01	.07	3.0	13.5	11.5	25.9
9011 urlington/Leeds									
987	57	.006	.030	.01	.10	2.7	13.7	11.7	23.8
988	52	.007	.030	.01	.04	2.3	11.7	8.4	38.2
989	61	.007	.020	.01	.06	3.8	14.4	10.6	30.4
990	54	.006	.030	.01	.03	2.7	13.9	11.1	27.4
9012 urlington/ ellington									
987	57	.004	.020	.01	.07				
988	56	.006	.020	.01	.03				
989	60	.005	.070	.01	.10				
990	57	.005	.030	.01	.04				

9001 terminated a end of 1987

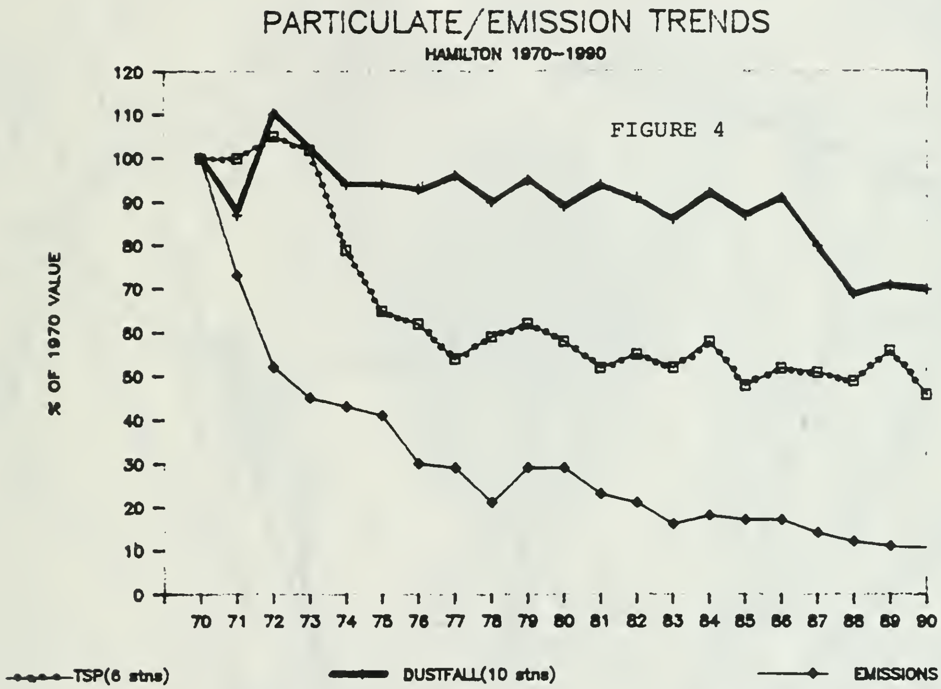
TABLE 3b CONSTITUENTS IN SUSPENDED PARTICULATE ug/m^3)

tation and Year	# of Samples	NICKEL Geo. Mean	NICKEL Max.	VANADIUM Geo. Mean	VANADIUM Max.	NITRATE Geo. Mean	NITRATE Max.	SULPHATE Geo. Mean	SULPHATE Max.
4-hour riterion		2.0		2.0					
9017 hatham/Frid									
987	58	.005	.070	.01	.07				
988	54	.007	.030	.01	.03				
989	55	.005	.020	.01	.07				
990	56	.005	.005	.01	.02				
9025 arton/Sanford									
987	53	.006	.060	.01	.14	3.9	17.6	13.0	40.9
988	43	.007	.030	.02	.04	3.7	10.3	10.9	35.7
989	59	.007	.030	.01	.04	4.7	13.4	11.7	35.2
990	52	.006	.030	.01	.03	3.3	9.7	11.0	25.5
9067 ughson/Macauley									
987	50	.004	.010	.01	.03				
988	54	.006	.030	.01	.04				
989	60	.005	.010	.01	.03				
990	52	.005	.010	.01	.05				
9114 ickers/East 18th									
987	55	.006	.120	.01	.09	4.6	12.5	11.6	24.4
988	46	.006	.050	.01	.03	4.0	12.3	11.4	31.3
989	56	.006	.050	.01	.03	4.6	12.8	11.0	36.7
990	55	.005	.020	.01	.03	2.8	11.4	8.8	21.9

TABLE 3C

CARBON CONTENTS IN SUSPENDED PARTICULATES (ug/m^3)

Station	Year	# of Samples	TOTAL CARBON Geo.Mean	TOTAL CARBON Max.	ELEMENTAL CARBON Geo.Mean	ELEMENTAL CARBON Max.	CARBONATE (CO_3) Geo.Mean	CARBONATE (CO_3) Max.
29011								
Burlington/Leeds	1987	57	10.8	40.0	3.6	17.0	0.7	7.5
	1988	52	11.4	33.4	3.5	16.7	1.0	4.1
	1989	61	11.1	30.9	3.5	11.8	1.1	6.6
	1990	54	9.3	44.7	3.2	16.4	0.6	9.1
29025								
Barton/Sanford	1987	53	9.4	34.0	2.9	17.9	0.2	3.9
	1988	43	9.5	28.4	2.9	16.0	0.5	5.9
	1989	59	8.6	23.2	3.1	11.8	0.2	2.2
	1990	52	8.5	35.0	3.2	14.4	0.4	2.8
29114								
Vickers/East 18th	1987	56	5.8	20.3	1.2	7.3	0.1	4.4
	1988	46	4.8	11.1	1.1	4.4	0.0	1.2
	1989	56	5.6	14.8	1.3	6.0	0.0	0.8
	1990	52	4.6	15.0	1.4	5.7	0.1	2.5
29102								
Beach Blvd.	1987	51	7.1	24.1	2.6	11.2	0.1	3.3
	1988	50	9.0	29.1	3.4	11.7	0.2	1.5
	1989	56	8.1	24.7	2.8	15.0	0.1	1.9
	1990	47	7.2	31.2	3.4	13.1	0.1	1.5


PARTICULATE/EMISSION TRENDS
HAMILTON 1970–1990
FIGURE 4
% OF 1970 VALUE
120
110
100
90
80
70
60
50
40
30
20
10
0
70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90
TSP(6 stns)
DUSTFALL(10 stns)
EMISSIONS

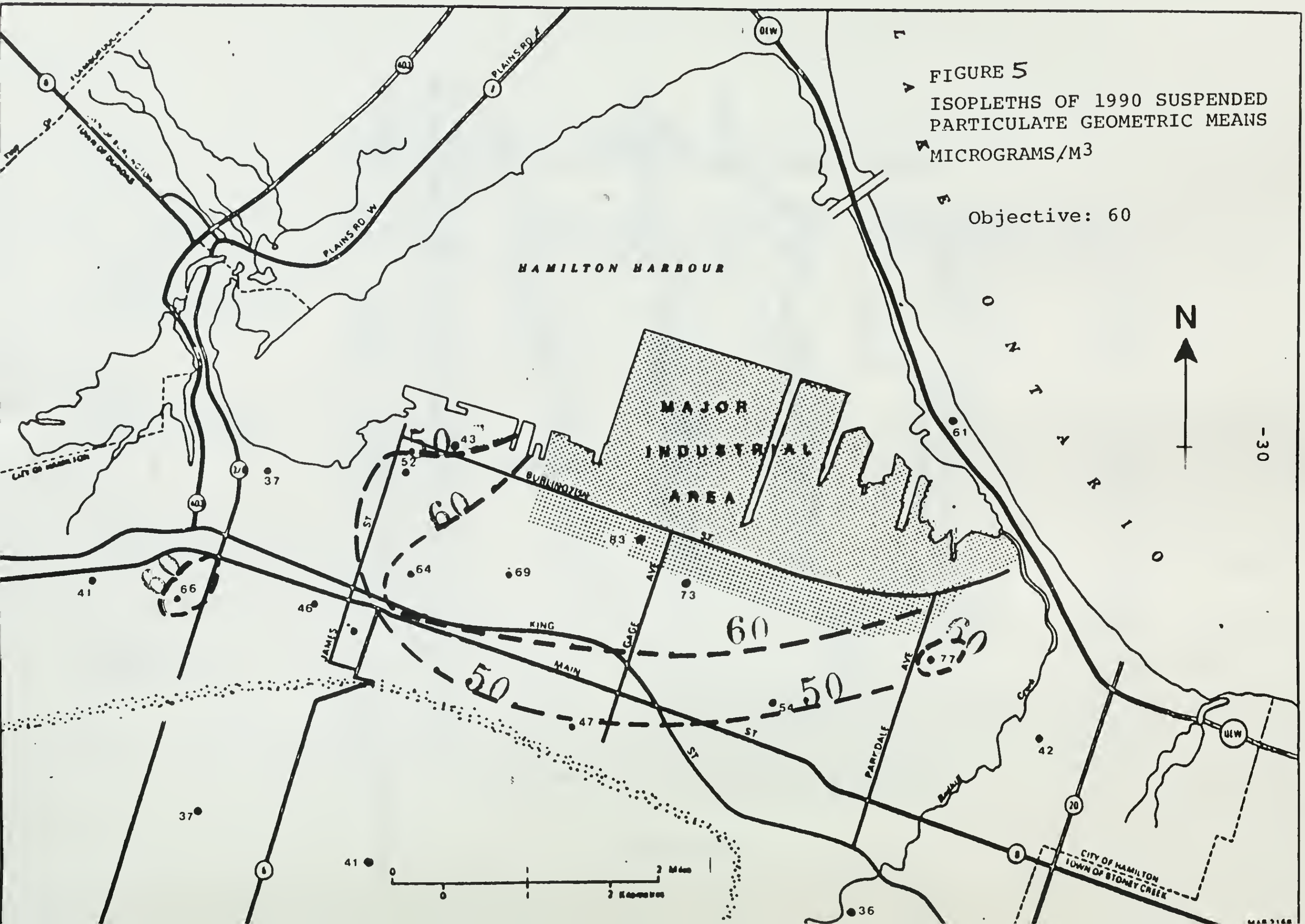


FIGURE 5
ISOPLETHS OF 1990 SUSPENDED PARTICULATE GEOMETRIC MEANS
MICROGRAMS/M3

Objective: 60

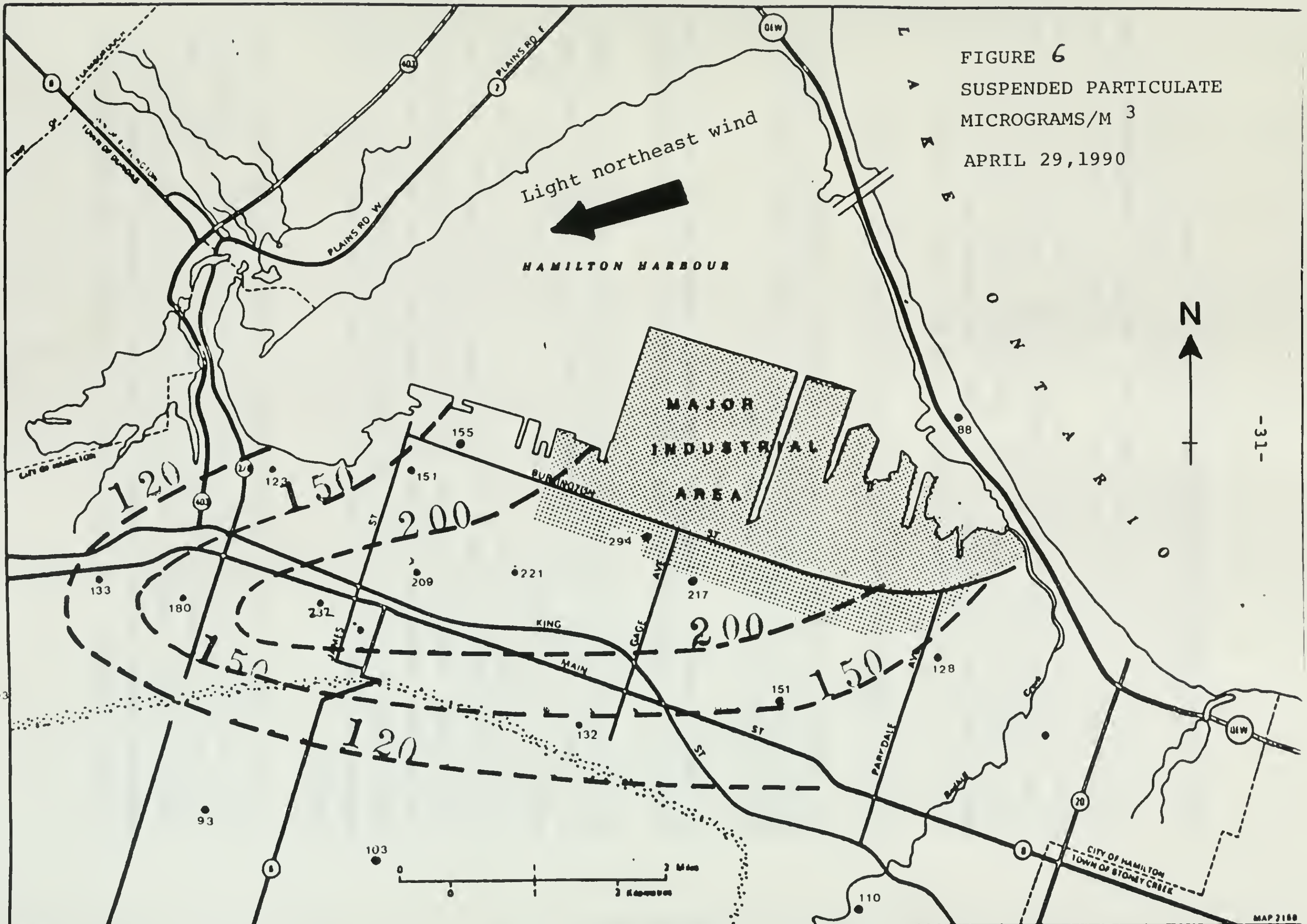


FIGURE 6
SUSPENDED PARTICULATE
MICROGRAMS/M 3
APRIL 29,1990

4.3.2 Soiling Index (Co-efficient of Haze)

Co-efficient of haze tape samplers operate continuously and determine hourly soiling values. Air is drawn through a filter paper, and the optical density of the soiled spot is measured by light transmittance. The instrument takes readings prior to and after sample collection. the resultant light obstruction is determined and transmitted on a real time basis to the data bank for the six telemetered stations. Data are given in Table 4.

In 1990, concentrations were all below the yearly objective.

The daily objective was most frequently exceeded at 29001 - Hughson/Hunter - a total of 15 days, followed closely by 29000 - Elgin/Kelly (14) and 29118 Main West (14).

Figures 7a and 7b illustrate the trends measured at each of the stations. A common declining trend is apparent at most locations.

Soiling index pollution roses (29001 and 29025 excluded) are given in Figure 8. The downtown (29000) and Mountain (29114) stations show the only evidence of industrial zone contributions, with slightly higher averages during northeast winds. Traffic would have contributed to these higher averages to some degree. The east 29105 (Nash/ Kentley) and west 29118 (Main West) stations generally did not show peaks pointing at the industries. The east station is remote from traffic, while the west station is adjacent to the Highway 403 cutoff. The west station shows peaks pointing to this roadway.

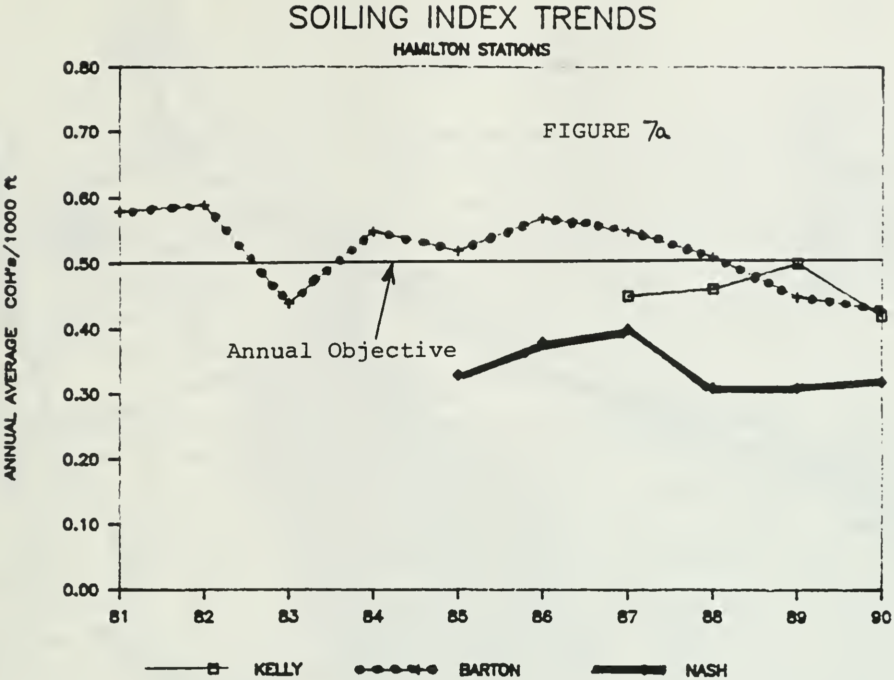
The Air Quality Index stations each recorded COH levels in the moderate range of the AQI (Table 2 and Figure 3a). Downtown (Elgin/Kelly) measured 78 moderate hours and 1 poor hour; East (Nash/Kentley) measured 18 moderate hours; West (Main West) 60 moderate hours and the mountain (Vickers) 28 moderate hours. Most of these readings occurred during morning rush hours and/or during

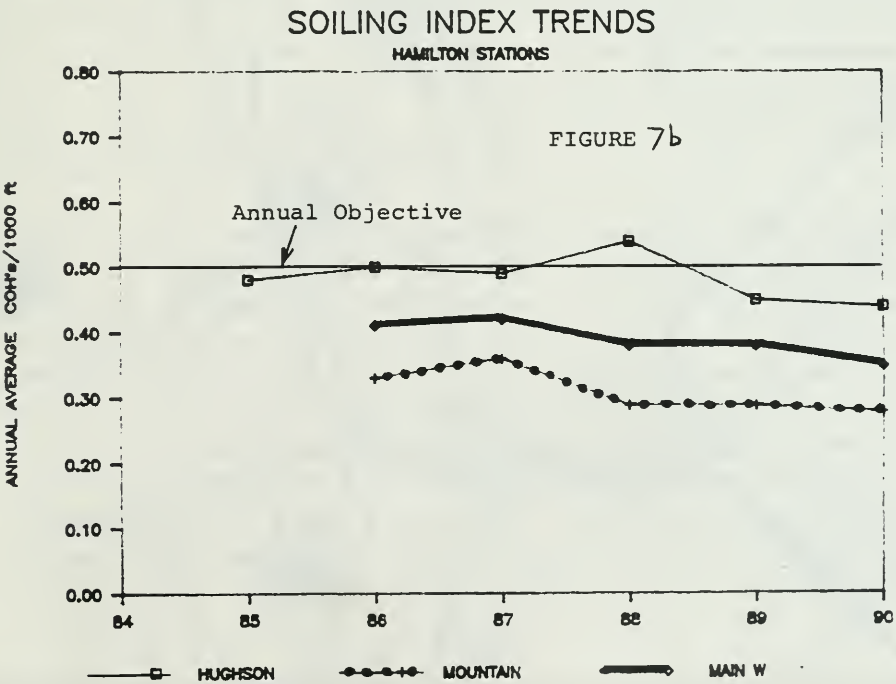
inversions, although the west station tended to measure high levels in late evening hours. Traffic was probably a major contributor in these readings.

TABLE 4
SOILING INDEX
UNITS - COH's Per 1000 linear ft. of air

Ontario Objectives: 24-hour - 1.0
1-year - 0.5

		Annual Average	Maximum 24-hour	Days Above 24-hour Objective
29000 Elgin/Kelly	1990	.42	1.9	14
	1989	.50	1.8	23
	1988	.46	2.2	20
29001 Hughson/Hunter	1990	.44	1.8	15
	1989	.45	1.6	15
	1988	.54	2.3	24
29025 Barton/Sanford	1990	.44	1.4	6
	1989	.45	1.5	10
	1988	.51	1.6	19
29105 Nash/Kentley	1990	.32	1.3	3
	1989	.31	1.1	1
	1988	.31	1.4	2
29114 Vickers/East 18th	1990	.28	2.0	4
	1989	.29	0.9	0
	1988	.29	1.2	4
29118 Main West/Hwy. 403	1990	.40	1.7	14
	1989	.38	1.4	3
	1988	.37	1.4	9


SOILING INDEX TRENDS
HAMILTON STATIONS
FIGURE 7a
Annual Objective
ANNUAL AVERAGE COH's/1000 ft
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
81
82
83
84
85
86
87
88
89
90
KELLY
BARTON
NASH


SOILING INDEX TRENDS
HAMILTON STATIONS
FIGURE 7b
Annual Objective
ANNUAL AVERAGE COH's/1000 ft
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
84
85
86
87
88
89
90
HUGHSON
MOUNTAIN
MAIN W

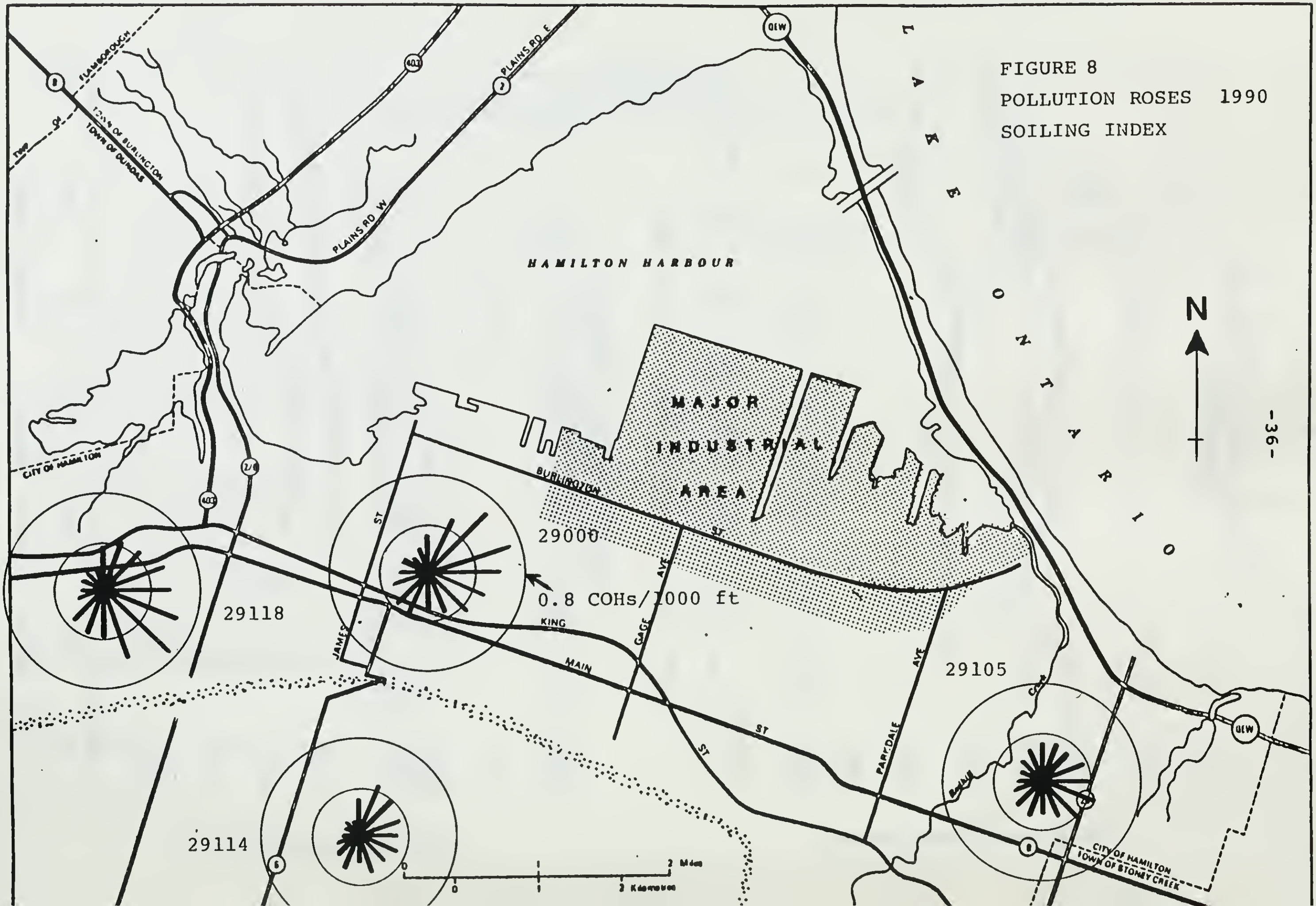


FIGURE 8
POLLUTION ROSES 1990
SOILING INDEX

4.3.3 Dustfall

Dustfall is the heavier, visible material which settles out of the atmosphere by gravity. It is collected in plastic containers during a 30 day exposure time. The collected material is weighed and expressed as a deposition rate of grams/square metre/30 days. The significance of observations is restricted to relatively local areas and dustfall objectives are based on visible deposit of dust rather than health effects.

Dustfall levels in 1990 (Table 5a) were similar to the previous year which remained well below pre-1987 levels. Significant improvement had been observed at that time. Still, a major portion of the lower city exceeded the objective. Figure 9 depicts dustfall isopleths, and shows that a small portion of the lower city near the industrial area was encompassed by the 9.0 grams/m^2/30 days contour which represents twice the objective. Conditions in this area were quite poor. As with the suspended particulate contour maps, the dustfall contour map in Figure 9 is not strictly a definitive representation of conditions city wide. Local influences affect some of the stations and the measurement is rather imprecise. The small contour drawn in Figure 9 indicates that particular station was subject to local influences, unrepresentative of general patterns.

Significantly lower levels were recorded progressively in 1987 and 1988 throughout the City, such that on average, dustfall has decreased by 25% from 1986 levels which in turn had remained relatively unchanged since the 1970's. Figure 4 displays the recent dustfall improvements following many years when levels remained virtually unchanged throughout the 1970's and 1980's. The absence of change in dustfall over the earlier years was surprising given the reductions in industrial process emissions and the correspondingly large reduction in suspended particulate concentrations noted in the same graph. Fugitive dust sources such as road dust,, stock piles, unpaved areas, vehicle emissions, etc.

are probably important in explaining this observation. The recent reductions represent the first significant improvement in dustfall levels in many years.

As mentioned, road traffic is a major source of the dust at several of the stations particularly at Ottawa Street (29010). The station at Chatham/Frid (29017) is also significantly affected by local fugitive sources such as road traffic and unpaved lots. A station only 2 blocks away (29217), recorded much lower levels.

Five dustfall stations were routinely analyzed for a scan of 10 metals (Table 5b). The most prominent metals were iron and manganese followed by copper and zinc, each showing a strong gradient with distance from the industrial zone with the exception of copper and zinc which for unknown reasons showed higher averages on the mountain at 29230.

Only one of the metals has an objective - lead, and it was not exceeded at any of the stations. Lead in dustfall varied little across the City, similar to the pattern found for suspended particulates.

The recent improvements cannot be ascribed to any single initiative. City staff have modified road cleaning practices. Industry has continued to control fugitive dust emissions by the use of sealants, road washing, landscaping, etc. Past measurements on company properties indicated that fugitive dust emissions were considerable. There have also been improvements in control of industrial point sources. All of the above control efforts must be maintained and expanded to achieve further improvements. These may include measures to reduce dirt track out onto streets and increased planting of vegetation. Continued efforts by both industry and the municipality will be necessary if objectives are to be attained in the lower city.

TABLE 5a
Dustfall - 1990
UNITS - GRAMS/SQUARE METRE/30 DAYS

Ontario Objectives: 1 month - 7.0
1 year - 4.5

	Annual Average 1988	1989	1990	Maximum 1990	# of Months Above Objective 1990
29001 Hughson/Hunter	4.4	4.7	4.2	7.3	1
29006 Queenston	4.4	4.9	4.8	9.6	2
29009 Kenilworth	3.7	4.4	4.5	8.6	1
29010 Burlington/Ottawa	16.2	16.3	14.6	24.6	11
29011 Burlington/Leeds	9.7	9.8	9.0	16.5	10
29012 Burlington/Wellington	6.1	6.0	5.5	13.8	1
29017 Chatham/Frid	8.1	7.4	7.7	22.3	4
29217 Chatham/Fanning	4.6	5.0	4.9	9.2	3
29025 Barton/Sanford	4.6	4.5	5.0	9.2	2
29230 Cameo Avenue	4.4	3.2	3.5	5.9	0
229231 Audrey/East 27th	3.5	5.3	4.1	8.7	1
29036 Roosevelt/Beach Road	14.1	15.6	15.6	25.5	10
29044 Wark/Beach Blvd.	7.4	7.2	7.8	12.5	7
29082 Leaside Road	6.5	6.9	7.3	13.2	5
29084 Rembe/Beach Blvd.	6.8	7.3	6.5	9.4	3
29102 Beach Blvd.	3.5	4.7	4.7	7.9	1
29136 Huntsville/Washington		-	3.2	5.3	0

TABLE 5b
DUSTFALL 1990 - METALS CONTENT
UNITS - GRAMS/SQUARE METRE/30 DAYS

		Iron	Manganese	Cadium	Cobalt	Chromium	Copper	Nickel	Lead	Vanad	
29001	Avg	.096	.009	.000	.001	.001	.001	.001	.002	.000	.006
Hughson/Hunter	Max	.349	.027	.001	.001	.001	.002	.001	.003	.001	.011
29010	Avg	.735	.060	.000	.000	.002	.001	.001	.002	.001	.039
Burlington/Ottawa	Max	1.558	.125	.001	.001	.005	.002	.001	.004	.001	.061
29230	Avg	.056	.003	.000	.001	.001	.008	.001	.001	.000	.031
Camden/Mohawk	Max	.118	.005	.001	.001	.001	.012	.001	.001	.001	.103
29036	Avg	.610	.017	.000	.000	.002	.006	.001	.003	.001	.024
Roosevelt/Beach Road	Max	1.268	.140	.001	.001	.003	.017	.001	.006	.001	.042
29102	Avg	.213	.016	.000	.000	.001	.002	.001	.001	.000	.007
Beach Blvd.	Max	.361	.025	.001	.001	.001	.011	.001	.002	.001	.014

Lead Objective: 0.1 (1 month)

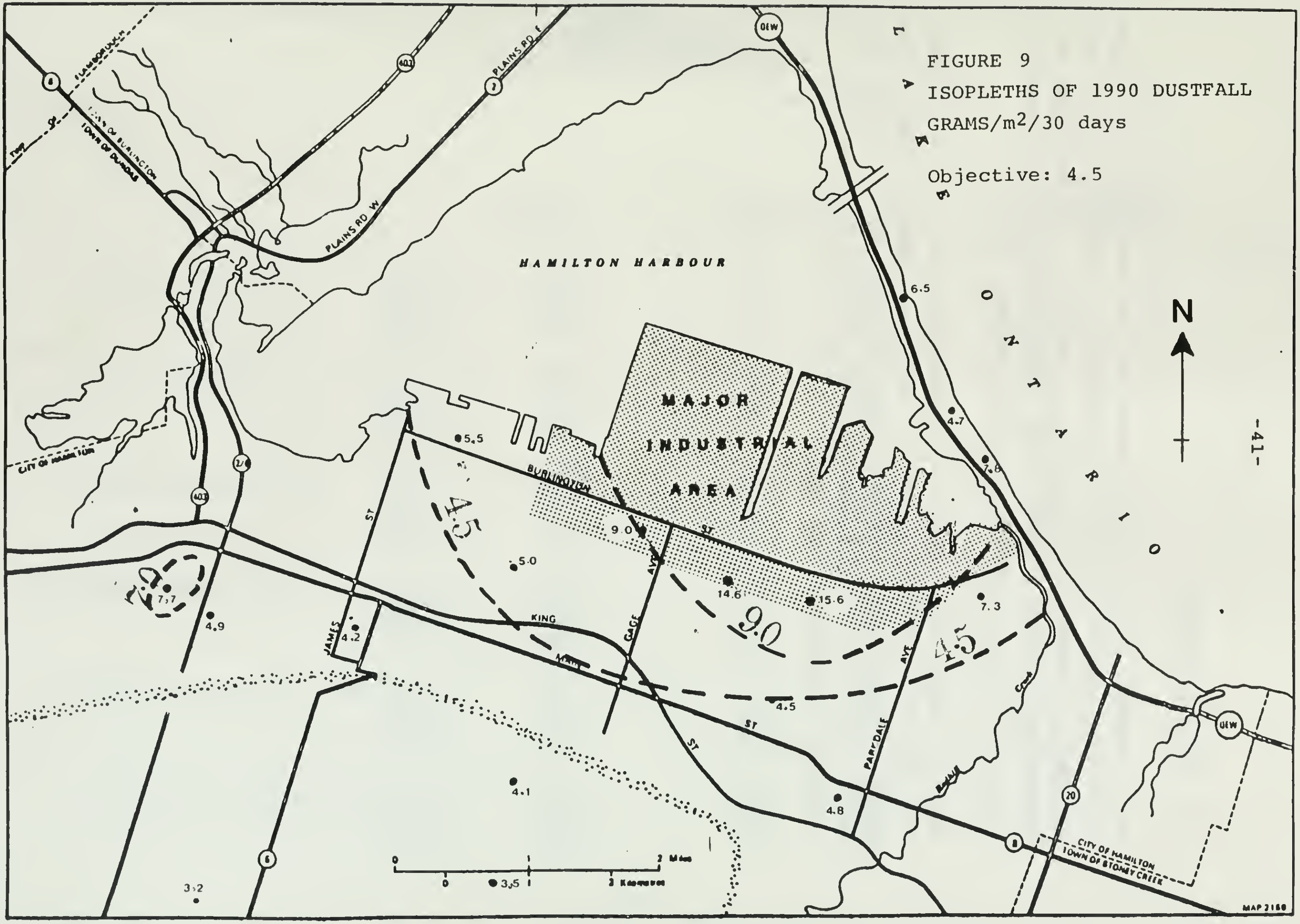


FIGURE 9
ISOPLETHS OF 1990 DUSTFALL
GRAMS/m^2/30 days

Objective: 4.5

4.4 Sulphur Dioxide

Most sulphur dioxide (SO_2) emissions in Hamilton stem from industrial sources. A smaller portion is accounted for by fuel burning in domestic space heating. Data for six stations are summarized in Table 6, which lists objectives based on vegetation damage (hourly and yearly) and health effects (daily).

Sulphur dioxide trends from all stations are illustrated in Figures 10a and 10b. In 1990, as in the past several years, the concentrations were acceptable based on the yearly, daily and hourly objectives. All readings at all four AQI stations fell in the very good range of the AQI.

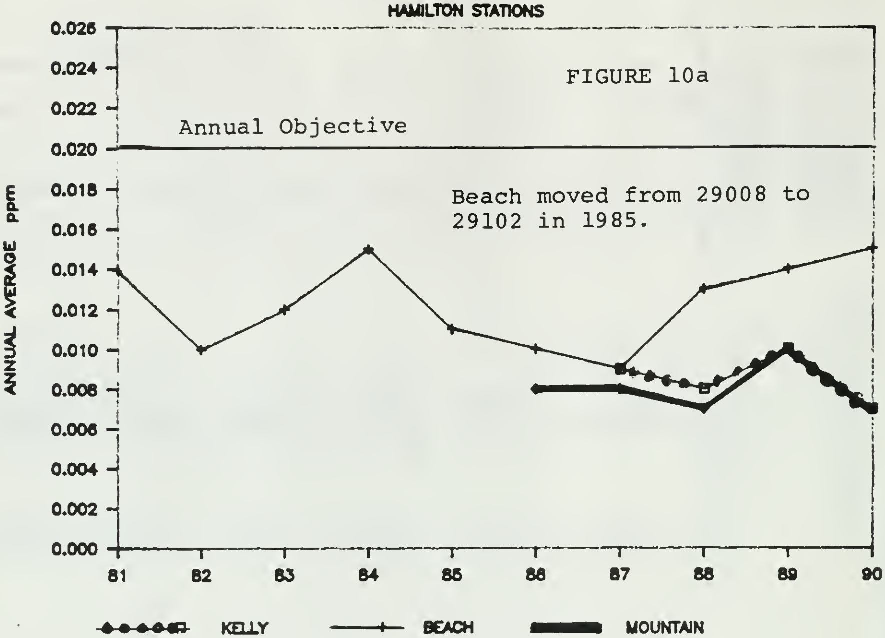
TABLE 6
SULPHUR DIOXIDE
UNITS - PARTS PER MILLION

Ontario Objectives: 1-hour - .25
24-hour - .10
1-year - .02

		Annual Average	Maximum 1-Hour	Maximum 24-Hour	# of Hours Above Objective 1-Hour	# of Hours Above Objective 24-hour
29000 Elgin/Kelly	1990	.007	.14	.05	0	0
	1989	.010	.21	.06	0	0
	1988	.008	.18	.05	0	0
	1987	.009	.24	.06	0	0
29102 Beach Blvd.	1990	.015	.14	.06	0	0
	1989	.014	.13	.06	0	0
	1988	.013	.17	.07	0	0
	1987	.009	.17	.05	0	0
29025 Barton/Sanford	1990	.006	.21	.07	0	0
	1989	.012	.15	.04	0	0
	1988	.009	.15	.04	0	0
	1987	.007	.15	.04	0	0
29105 Nash/Kentley	1990	.005	.11	.03	0	0
	1989	.006	.15	.02	0	0
	1988	.005	.11	.03	0	0
	1987	.005	.14	.03	0	0
29114 Vickers/East 18th	1990	.007	.13	.05	0	0
	1989	.010	.14	.05	0	0
	1988	.007	.13	.04	0	0
	1987	.008	.36	.06	1	0
29118 Main West/Hwy. 403	1990	.005	.09	.03	0	0
	1989	.005	.20	.03	0	0
	1988	.005	.11	.03	0	0
	1987	.006	.19	.03	0	0

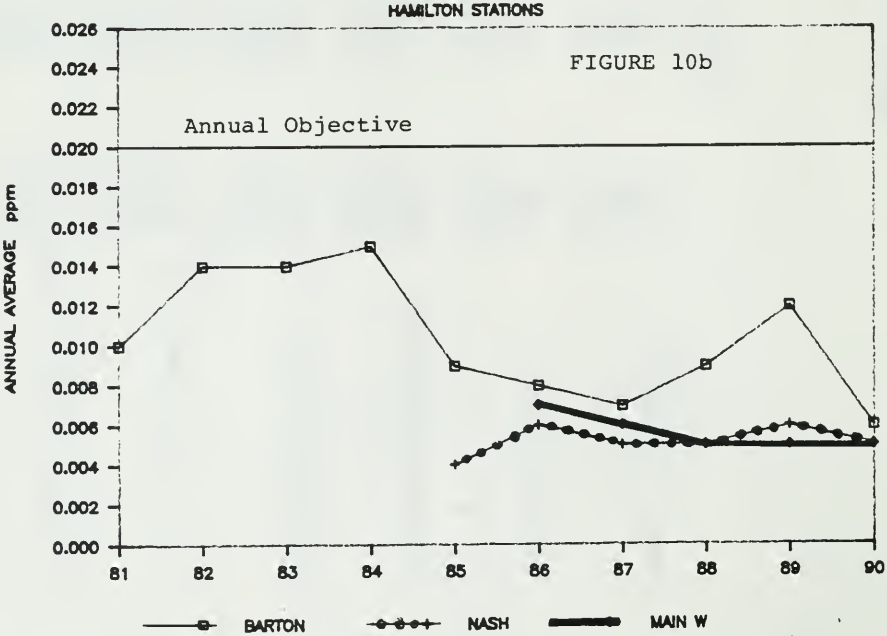
SULPHUR DIOXIDE TRENDS

HAMILTON STATIONS



SULPHUR DIOXIDE TRENDS

HAMILTON STATIONS



4.5 Total Reduced Sulphur

These gases are comprised of hydrogen sulphide (H_2S), the "rotten egg" gas and other sulphur compounds and the mixture is referred to as total reduced sulphur (TRS). There are no general objectives for TRS. However, an hourly objective for H_2S of 20 ppb may be compared to the observed values since most emissions are thought to consist mainly of H_2S. The data given in Table 7 are also compared to the 10 ppb level - an approximate odour threshold for H_2S. TRS was measured at five stations - Barton, Elgin, Beach, Main West and the mountain.

The major sources of hydrogen sulphide and related sulphur compounds are the steel industry's coke ovens and related by-products operations, certain slag quenching processes, a tar plant and, under upset conditions, a local manufacturer of carbon black. The sewage treatment plant is another potential source of odours but only during upset conditions.

The Beach Blvd area remained the most seriously affected location by TRS. The Beach station recorded 117 hours over 10 ppb in 1990 compared to 140 hours in 1989. Data indicate that Dofasco Inc. was the prime source affecting the Beach1station. That company has been experimenting with methods of reducing emissions from slag quenching. The Carbochem plant and Stelco also affected the Beach area but to a much lesser degree.

In 1990, levels at the other city stations remained relatively similar to 1989 following dramatic improvements that were recorded in 1987. That improvement was related to Stelco Inc. replacing direct contact coolers in the coke oven by-product area with indirect coolers in April, 987.

The Barton station measured 140 hours above 10 ppb in 1990 compared to 67 hours in 1989. However, most of these readings occurred during the spring inversion season. These were only 10 hours over

10 ppb after May. The mountain station measured 24 such hours (most in the moderate range of the AQI) in 1990 compared to 12 hours in 1989. The Elgin/Kelly station downtown measured 18 hours over 10 ppb in 1990, all in the moderate range of the AQI. Main West recorded 15 hours over 10 ppb, all in the moderate range.

Figures 11a and 11b display the trend of 10 ppb exceedences per year at each station. Up to 1990, the Barton station clearly shows a decreasing trend during the 1980's with a dramatic decrease observed in 1987. Following the increase in early 1990, 1991 levels returned to a low level again.

Not surprisingly, the TRS pollution roses for the four stations given in Figure 12 point strongly toward the industrial area except for Main West which points toward Hwy. 403.

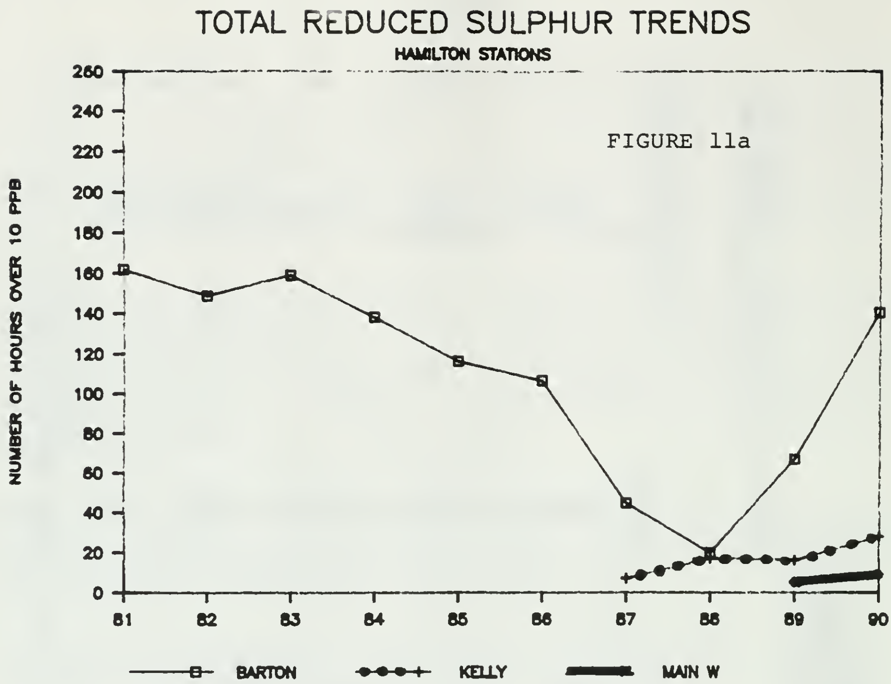
The Ministry is continuing to work with Stelco, Carbochem, and Dofasco to further reduce their TRS emissions.

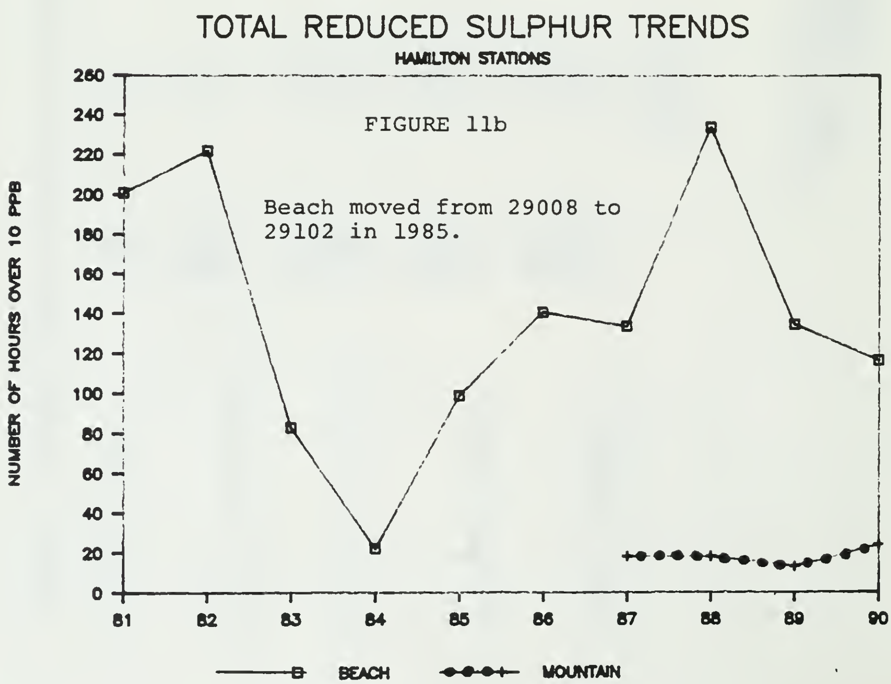
TABLE 7
TOTAL REDUCED SULPHUR
UNITS - PARTS PER BILLION

Ontario Objectives: 1-Hour - 20
(Hydrogen Sulphide)

		Annual Average	Maximum	# of Hours Above 10 ppb	# of Hours Above 20 ppb
29000 Elgin/Kelly	1990	0.9	15	28	0
	1989	0.8	33	16	1
	1988	0.8	21	18	1
	1987	0.8^{11}	14	12	0
29102 Beach Blvd.	1990	1.6	45	117	17
	1989	2.4	32	140	10
	1988	2.5	54	234	30
	1987	1.6	33	134	15
29025 Barton/Sanford	1990	1.2	35	140	14
	1989	1.2	27	67	2
	1988	0.9^{7}	16	20	0
	1987	0.9	30	45	6
29114 Vickers/East 18th	1990	1.1	26	24	2
	1989	0.7	16	12	0
	1988	1.2	17	26	0
	1987	0.8	19	21	0
29118 Main West	1990	1.0	15	16	0
	1989	0.9	13	10	0

* Numerical exponent refers to number of months sampled when less than 12.


TOTAL REDUCED SULPHUR TRENDS
HAMILTON STATIONS
FIGURE 11a
NUMBER OF HOURS OVER 10 PPB
260
240
220
200
180
160
140
120
100
80
60
40
20
0
81
82
83
84
85
86
87
88
89
90
BARTON
KELLY
MAIN W


TOTAL REDUCED SULPHUR TRENDS
HAMILTON STATIONS
FIGURE 11b
Beach moved from 29008 to
29102 in 1985.
NUMBER OF HOURS OVER 10 PPB
260
240
220
200
180
160
140
120
100
80
60
40
20
0
81
82
83
84
85
86
87
88
89
90
BEACH
MOUNTAIN

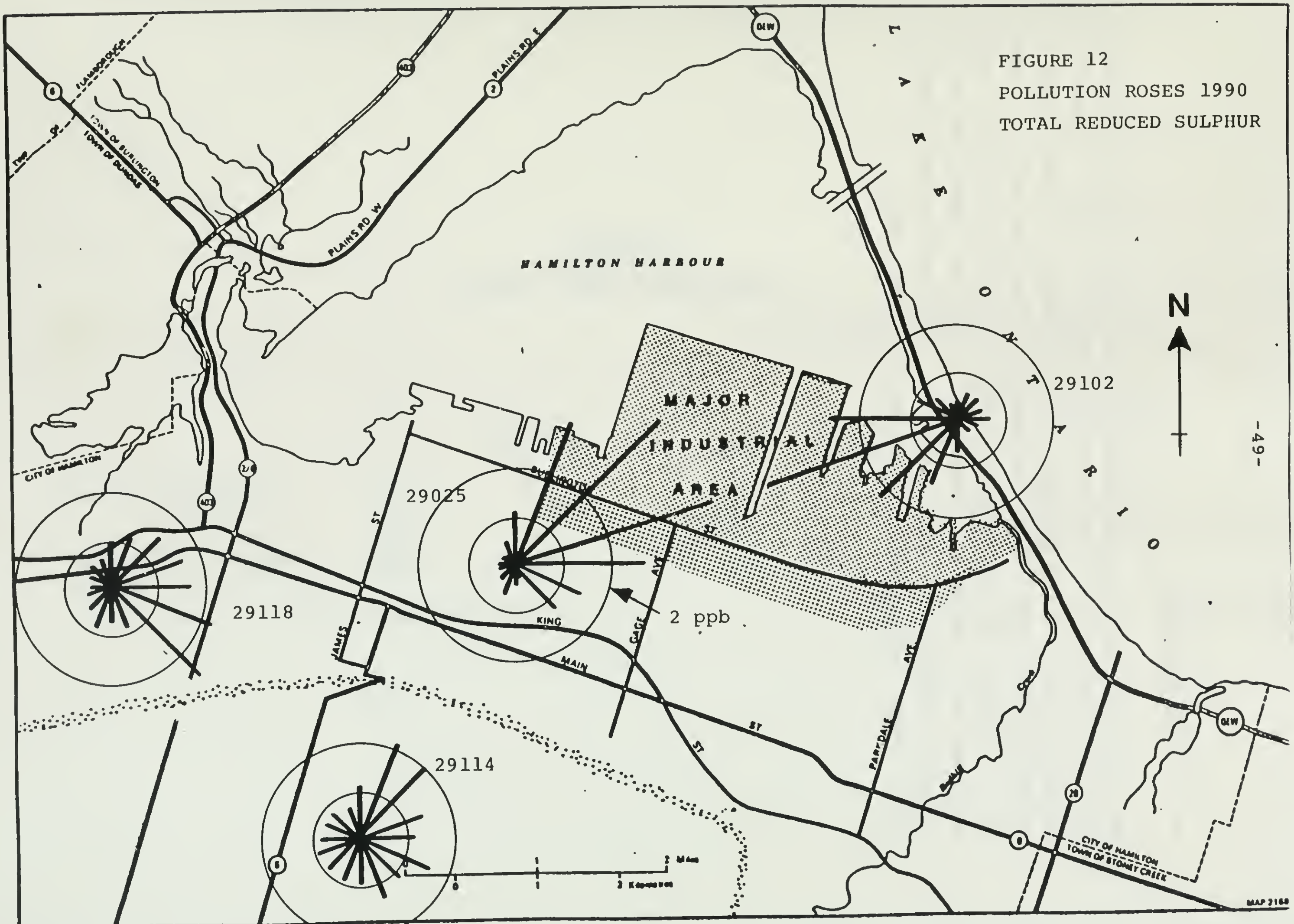


FIGURE 12
POLLUTION ROSES 1990
TOTAL REDUCED SULPHUR

4.6 Carbon Monoxide

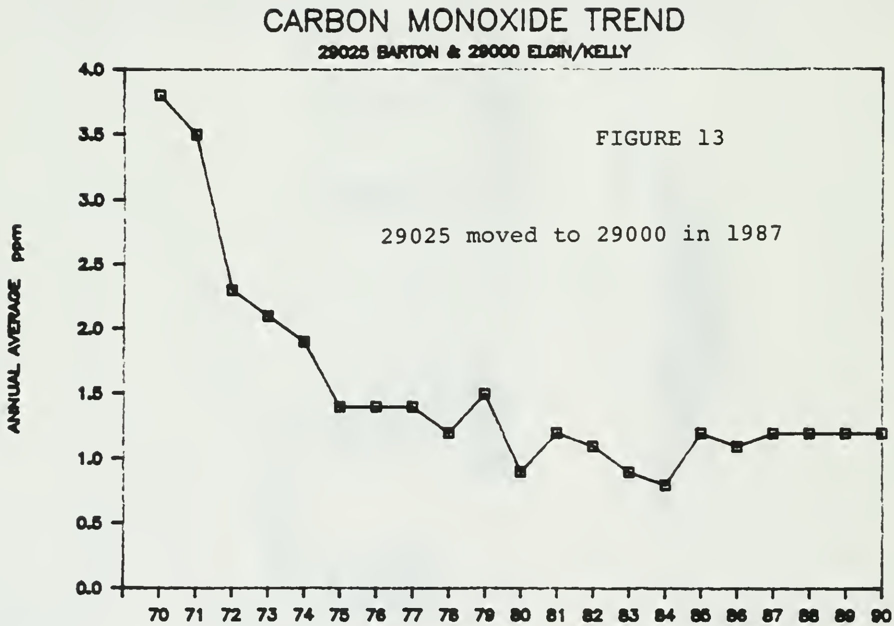
The major source of carbon monoxide is automobile traffic although there are also some contributions from industry. Due to automotive emission controls, the levels measured at Barton Street (moved to Elgin/Kelly in 1987) decreased greatly since the 1970's (Figure 13). In 1990, the levels were similar to the previous few years and were well below the objectives which are based on health effects. Data are given in Table 8. All downtown AQI readings (both 1-hour and 8-hour) fell in the very good range.

TABLE 8
CARBON MONOXIDE
UNITS - PARTS PER MILLION

Ontario Objectives: 1-hour - 30
8-hour - 13

		Annual Average	Maximum 1-Hour	Maximum 8-Hour	# of Hours Above Objective 1-Hour	# of Hours Above Objective 8-hour
29000 Elgin/Kelly	1990	1.2	7	6	0	0
	1989	1.2	9	4	0	0
	1988	1.2	11	5	0	0
29025 Barton/Sanford	1987	1.2*	8	5	0	0
	1986	1.1	12	6	0	0

* 29025 moved to 29000 in February 1987.


CARBON MONOXIDE TREND
29025 BARTON & 29000 ELGIN/KELLY
FIGURE 13
29025 moved to 29000 in 1987
ANNUAL AVERAGE ppm
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90

4.7 Oxides of Nitrogen

The primary sources of oxides of nitrogen are high temperature combustion sources including the automobile. The most abundant oxides are nitric oxide (NO) and nitrogen dioxide (NO_2). Nitric oxide is a direct emission which is then oxidized in the atmosphere to form nitrogen dioxide. Both pollutants were monitored continuously at Elgin/Kelly, Main West, Beach Blvd. and the mountain. At each station, a single instrument makes measurements of NO, NO_2 and total nitrogen oxide. Nitric oxide is measured directly, and the total oxides are measured by internally converting all other nitrogen oxides to nitric oxide. The instrument then determines nitrogen dioxide to be the difference between the first two measurements.

Objectives exist only for nitrogen dioxide and these are based on odour threshold levels (hourly) and health effects (24-hourly). Other adverse effects occurring at much higher levels include vegetation damage, reduced visibility and corrosion of metals. The objectives were not exceeded in 1990, similar to previous years.

Data for nitrogen dioxide are given in Table 9 and yearly trends are illustrated in Figure 14. Both Elgin/Kelly and Beach stations showed similar concentrations to previous years and similar to the west end site 29118 on Main Street West, and slightly higher than the mountain station. A levelling off in concentrations at the two longer established stations is evident.

Data for nitric oxide are given in Table 10 and yearly trends are given in Figure 15. Note the abrupt decrease in levels at Beach following the move away from the highway to 29102 in 1985. The station is now much less affected by vehicle emissions.

The new Main Street West site recorded higher levels in 1990 than the other four; it is being affected by traffic on Main Street West and the Highway 403 cutoff. The mountain station recorded the lowest average, it being the least influenced by traffic.

Oxides of nitrogen are an important factor in the photochemical cycle of ozone in the atmosphere. This will be discussed in the next section of this report.

TABLE 9
NITROGEN DIOXIDE
UNITS - PARTS PER MILLION

Ontario Objectives: 1-hour - .20
24-hour - .10

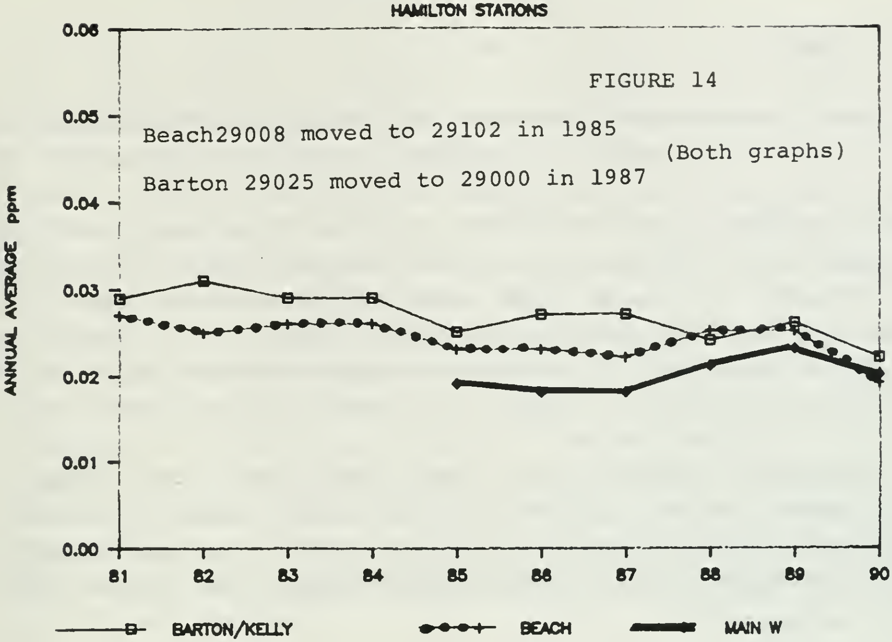
		Annual Average	Maximum 1-Hour	Maximum 24-Hour	# of Hours Above Objective 1-Hour	# of Hours Above Objective 24-hour
29102 Beach Blvd.	1990	.019	.08	.06	0	0
	1989	.023	.08	.06	0	0
	1988	.025	.11	.06	0	0
	1987	.022	.11	.06	0	0
29000 Elgin/Kelly	1990	.022	.09	.05	0	0
	1989	.026	.09	.06	0	0
	1988	.024	.13	.07	0	0
	1987	.027	.16	.06	0	0
29114 Vickers/East 18th	1990	.016	.08	.05	0	0
	1989	.017	.09	.04	0	0
29118 Main West/Hwy. 403	1990	.020	.09	.05	0	0
	1989	.023	.10	.05	0	0
	1988	.021	.11	.06	0	0
	1987	.018	.10	.07	0	0

TABLE 10
NITRIC OXIDE
UNITS - PARTS PER MILLION

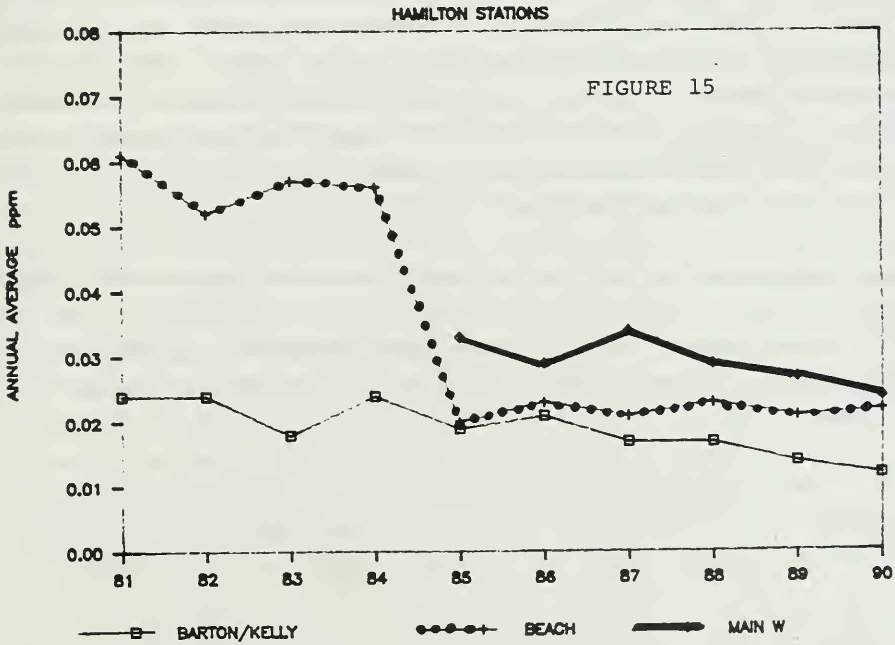
No MOE Objective

		Annual Average	Maximum 1-hour	Maximum 24-hour
29102 Beach Blvd.	1990	.022	.67	.16
	1989	.021	.47	.11
	1988	.023	.31	.12
	1987	.021	.42	.14
29000 Elgin/Kelly	1990	.012	.49	.17
	1989	.014	.33	.11
	1988	.017	.56	.23
	1987	.017	.47	.15
29114 Vickers/East 18th	1990	.011	.31	.13
	1989	.009	.20	.07
29118 Main West/Hwy. 403	1990	.024	.54	.22
	1989	.027	.54	.20
	1988	.031	.91	.24
	1987	.034	.57	.22

NITROGEN DIOXIDE TRENDS



NITRIC OXIDE TRENDS



4.8 Ozone

Oxidants are produced by photochemical reactions involving oxides of nitrogen, hydrocarbons and sunlight. Ozone accounts for most of the oxidants produced. The sources of the precursor pollutants are mainly industrial and automotive. The rate of oxidant production is dependent on the quantity of precursor pollutants, temperature and intensity of sunlight. The ozone problem at ground level is a problem of too much ozone. The problem in the upper atmosphere is a loss of ozone thus allowing too much ultraviolet light to reach the earth's surface. The Federal Government monitors these levels.

As mentioned earlier, this report deals only with Ontario measurements of the ground level pollutant ozone. However, regulations have been passed by the Ontario Ministry to control the use and disposal of CFCs (chlorofluorocarbons) which destroy upper level ozone.

Ozone at ground level is known to cause respiratory problems, and at higher concentrations, people can experience adverse health effects. Ozone is also injurious to different types of vegetation including certain tobacco, bean and tomato crops. The one-hour objective for ozone (80 ppb) is based on such vegetation effects, however, jogging is not advisable for sensitive people above such levels since strenuous exercise increases breathing rates and thus increases the amount inhaled.

Ozone concentrations follow very definite annual and daily trends. Highest levels occur during the summer (May - September), and the daily maxima usually occur during late afternoon. Both patterns are directly related to temperature and the amount and intensity of sunlight.

Ozone was measured at the Elgin/Kelly station, at the east site 29105 (Nash/Kentley), the west site 29118 (Main West) and mountain station 29114 (Vickers/E 18th). Data are summarized in Table 11 while yearly trends are illustrated in Figure 16.

In 1990, ozone was similar to the previous year and levels were fairly uniform City-wide. The hourly objective of 80 ppb was exceeded in a range from 19 to 61 hours at the four Hamilton stations. All but one of these readings fell in the moderate range of the AQI. The mountain site recorded the most exceedences.

During each elevated ozone episode, winds were southwest and warm temperatures prevailed. The origin of the ozone is believed to be the United States. This is confirmed by stations close to the shore of Lake Erie. One such station at Long Point, upwind of all Canadian sources, measured over 160 hours above the objective, the most in the Province.

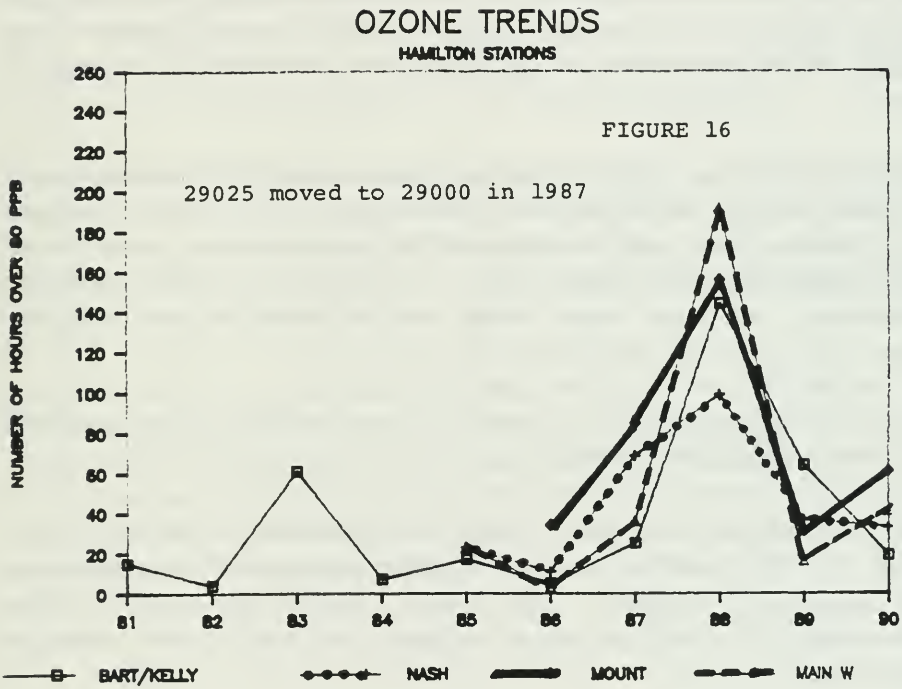
Ozone, hydrocarbons and oxides of nitrogen can be transported over great distances and can be augmented by local sources. However, Hamilton and other major urban areas usually experience lower ozone concentrations than their more rural surroundings during peak occurrences due to the numerous high temperature combustion sources which produce scavengers of ozone such as nitric oxide. Nonetheless, ozone and other oxidants remain a problem in the Hamilton area. Due to the complexity of oxidant formation and the long range transport phenomenon, this problem will have to be resolved on a national and international rather than local scale.

In recognition of the seriousness of the ground level ozone problem, the Canadian Council of Ministers of the Environment decided in 1988 to develop a management plan for the control of nitrogen oxides (NOx) and volatile organic compounds (VOC). A three phase NOx and VOC control plan was developed to resolve the ozone problem by the year 2005. This program is being undertaken in concert with the United States which plans similar strategies.

TABLE 11
OZONE
UNITS - PARTS PER BILLION

Ontario Objective: 1-hour - 80

Station	Year	Annual Average	Maximum 1-hour	# of Hours Above
29000 Elgin/Kelly	1990	17.6	95	19
	1989	16.7	127	64
	1988	17.9	137	144
	1987	15.2	105	24
29105 Nash/Kentley	1990	19.9	111	33
	1989	19.2	106	37
	1988	20.6	132	108
	1987	19.2	111	69
29114 Vickers/East 18th	1990	21.5	117	61
	1989	19.5	99	31
	1988	19.8	131	156
	1987	19.8	114	85
29118 Main W./Hwy. 403 School	1990	17.7	114	41
	1989	15.9	102	16
	1988	18.3	135	196
	1987	14.3	103	36


OZONE TRENDS
HAMILTON STATIONS
FIGURE 16
29025 moved to 29000 in 1987
NUMBER OF HOURS OVER 80 PPB
260
240
220
200
180
160
140
120
100
80
60
40
20
0
81
82
83
84
85
86
87
88
89
90
BART/KELLY
NASH
MOUNT
MAIN W

4.9 Fluoridation

This measurement is a relatively simple assessment used to determine quantities of various fluoride compounds in the ambient air. A lime coated paper is exposed to the atmosphere for one month and is then chemically analyzed for fluoride. The fluoride objectives are based on vegetation damage and for this reason, the objective is more stringent during the growing season. For the period of April 1 to October 31 the objective is 40 micrograms/100 square centimetres/ 30 days while for the remainder of the year it is 80.

In Hamilton, the major fluoride sources are the basic oxygen furnaces used by the major steel industries which require fluorspar as a fluxing agent and a brick manufacturing plant at the base of the escarpment near Gage Park. In addition to these process emissions, there are other minor sources such as coal burning, since coal contains trace amounts of fluoride.

Data for 1990 are summarized in Table 12 and the yearly trend since 1970 is illustrated in Figure 17.

The trend graph shows that levels have declined steadily to the point in 1990 that the monthly objectives were only occasionally and marginally exceeded. The Stelco strike may have had some contribution to this decrease, however low levels were measured year-round in 1990.

A contour plot of yearly averages is given in Figure 18. A ring can be drawn around the industrial area as shown. The worst station within this area recorded only one sample above the monthly objectives.

The most prominent individual source of airborne fluoride in the city is the Hamilton Brick Co., near Gage Park. A network of five monitors recorded high levels well above objectives again in 1990.

It should be noted that elevated fluoride concentrations near brick plants are common. A 1983 report undertaken jointly by the Ontario Ministries of Environment, Health and Labour concluded that " the maximum additional intake of fluoride resulting from exposure to brick plant fluoride emissions is small. It is concluded that this additional intake could be considered to fall within the normal range of fluoride intake from dietary sources and as such would not be expected to induce health effects in an exposed population" (p. 24). This report was based on measurements near a Toronto and a Brampton brick plant. Concentrations in Toronto and Brampton were comparable to those measured at the Hamilton stations.

Although human health concerns are not a problem, light to moderate injury to sensitive vegetation (mostly silver maple) has been observed in the vicinity of the plant in the past. Injury and fluoride concentrations in the vegetation decreased with distance from the brick plant.

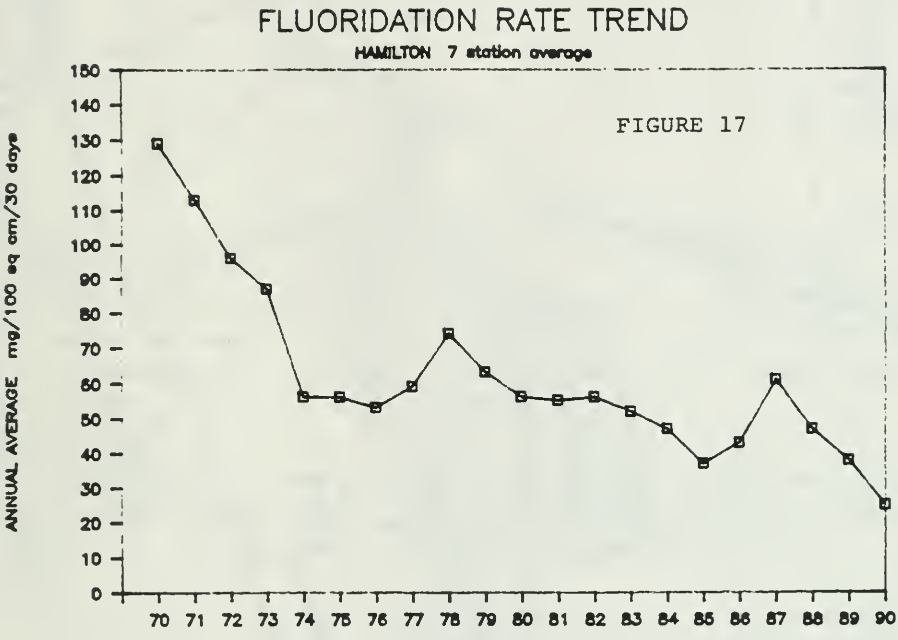
Hamilton Brick Co. has upgraded their drying ovens and reduced the temperatures used in the process in conjunction with the installation of more efficient kilns. These modifications have had little effect in a reducing fluoride levels surrounding the plant. The Ministry is continuing abatement activities with the company in an attempt to reduce emissions to an acceptable level.

TABLE 12
FLUORIDATION RATE - 1990
UNITS - MICROGRAMS PER SQUARE CENTIMETRE/30 DAYS

Ontario Objectives: April 1 TO October 31 - 40
November 1 to March 31 - 80

LOCATION	Geometric Mean 1987	1989	1990	Maximum 1990	# of Months Above Objective
29001 Hughson/Hunter	30	28	14	24	0
29012 Burlington/Wellington	24	27	13	26	0
29025 Barton/Sanford	40	33	18	24	0
29054 Beach Road/Conrad	53	39	21	28	0
29059 Burlington/Gage	63	49	30	38	0
29062 Briarwood School/King St E	57	47	46	112	1
29066 Killarney/Beach Blvd.	59	46	32	50	0
29115 London/Justine	206^{9}	165	143	247	8
29116 Dalkeith/Ottawa	66	56	35	67	1
29119 Morley/Parkdale	42	40	24	36	0
29120 Dickson/Burlington	45	45	32	86	1
29126 Rosslyn/Montclair	167^{9}	121	74	151	3
29127 Lawrence/Balmoral	998^{9}	1000	663	1107	9
29129 Province/Justine	103^{9}	119	75	142	4
29131 Central/Graham	84^{9}	93	50	68	3

* Numeric exponent refers to number of months sampled when less than 12.


FLUORIDATION RATE TREND
HAMILTON 7 station average
FIGURE 17
ANNUAL AVERAGE mg/100 sq cm/30 days
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90

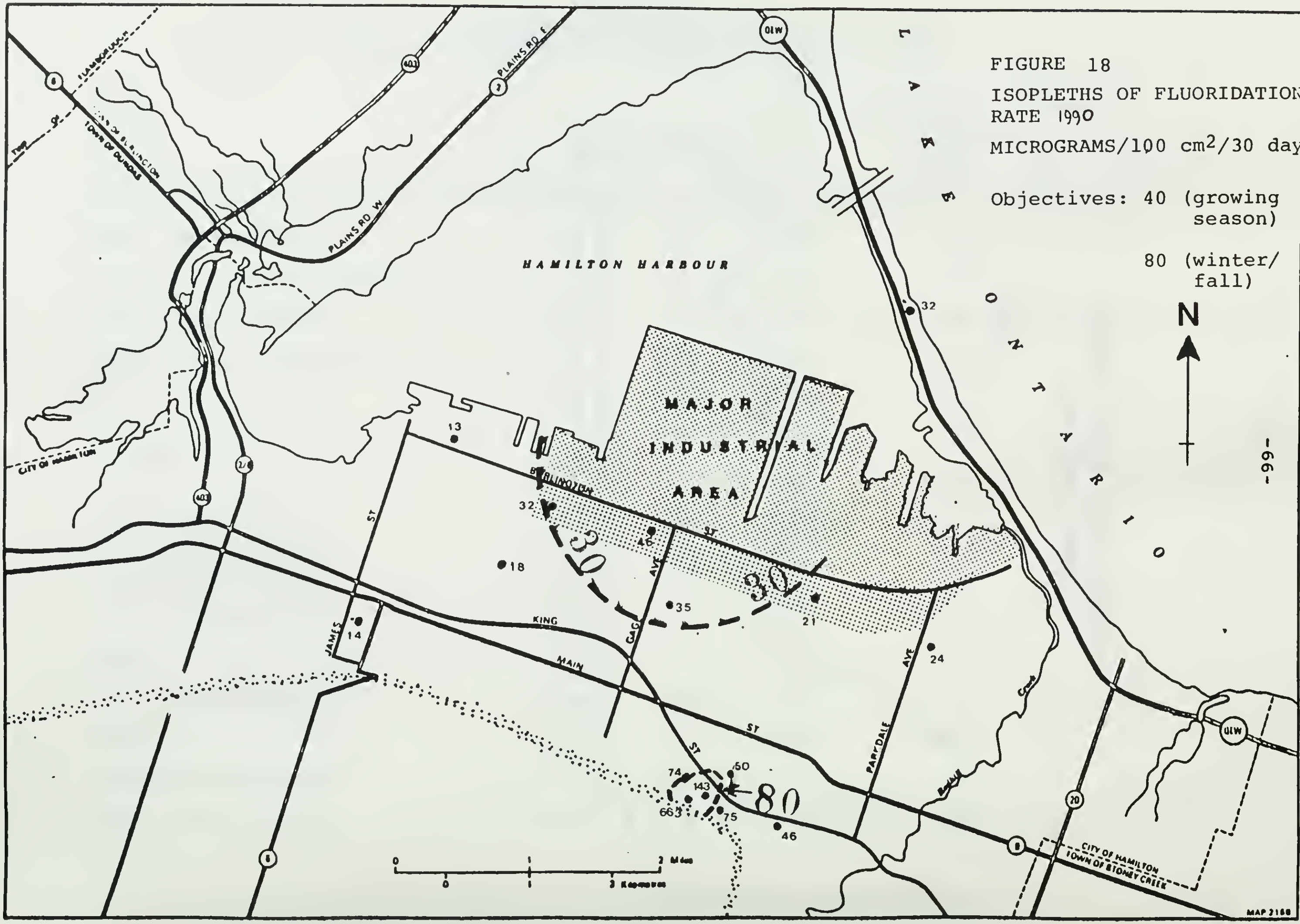


FIGURE 18

ISOPLETHS OF FLUORIDATION RATE 1990

MICROGRAMS/100 cm^2/30 days

Objectives: 40 (growing season)

80 (winter/ fall)

5. AIR MONITORING NEAR STEETLEY INDUSTRIES

In addition to the network in the City of Hamilton, the Ministry has been monitoring airborne dust levels near Steetley Industries, a limestone quarry operation near Greensville in the Town of Flamborough since 1974. In 1990, the six station network was comprised of 5 dustfall jars and two high volume samplers as illustrated in Figure 19.

The 1990 suspended particulate data continued to exceed the objective at station 29111 - Westfield, although a clear improvement was evident from prior years. The annual geometric mean reduced to 71 ug/m^3 from 94 in 1989. There were 10 exceedences of the daily objective of 120 ug/m^3 compared to 16 in 1989.

The Westfield exceedences occurred mostly during southwest winds indicating the quarry operation and/or construction activities between the station and quarry were the main source.

Further away in the village of Greensville at station 29112, the levels were much lower and also showed a clear improvement from prior years. The geometric mean fell to 32 ug/m^3 from 51 in 1989 and all samples were below the daily objective. . However, the samples were analyzed for carbonate (limestone is calcium carbonate) and these levels correlated weakly positive with northerly wind direction frequency, suggesting some effect of Steetley.

Trends in suspended particulates at the two stations are presented in Figure 20.

Dustfall levels (also Table 13) in 1990 were similarly improved. All five dustfall averages were below the annual objective and three of the stations recorded a single exceedence of the monthly objective.

Figure 21 gives the yearly trend of dustfall for four of the stations. A declining trend during the 1980's is apparent.

Quarry operations have moved north of the 4th Concession but stations 29096 and 29097 nearest these operations showed the greatest improvement in 1990.

In January 1987, Steetley installed a new electrostatic precipitator to control their #1 and #3 kilns. The emissions from these kilns were also directed into a single tall stack, eliminating a shorter stack and thus providing better dispersion of the remaining process emissions. In 1988, the company installed a conveyer system form the north quarry operations to the plant, eliminating truck traffic, a source of dust. A slurry system was also installed for disposal of precipitator dust by wet methods. Previously, this dust was trucked in dry form causing dust problems. As well, the company installed adjustable stackers reducing fugitive emissions from storage piles and in late 1989 the #3 feed stockpile was enclosed. Steetley installed a third electrostatic precipitator in late 1989, so that all three kilns now have their own separate precipitator. In 1991 the company discontinued the use of portable crushers and began using a new secondary crusher completely contained in a building. The dustfall and suspended particulate data indicate these improvements have had a positive effect.

The remaining dust sources at Steetley's processing plant are the dry fines plant, and various fugitive dust sources such as stock piles and roads.

TABLE 13

SUMMARY STATISTICS - GREENSVILLE

PARTICULATES NEAR STEETLEY QUARRY

ONT. OBJECTIVES: 120 (24 hour)
60 (annual geo. mean)

SUSPENDED PARTICULATES - micrograms per cubic metre

STATION	GEOMETRIC MEAN 1988	1989	1990	1990 MAXIMUM 24 HR	NO. OF SAMPLES	NO. TIMES OVER OBJECTIVE (1990) 24	1 YR
29111 OFIELD S/HWY 5	110	94	71	173	51	10	1
29112 HARVEST/WESITE	39	51	32	82	52	0	0

ONT. OBJECTIVES: 7.0 (1 MONTH)
4.5 (ANNUAL AVERAGE)

DUSTFALL - grams/square metre/30 days

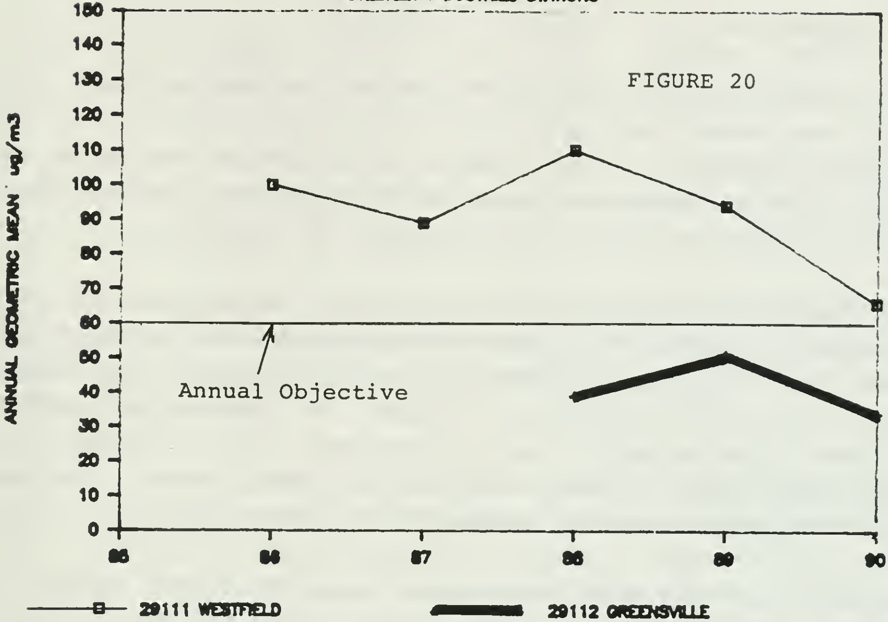
STATION	ANNUAL AVERAGE 1988	1989	1990	1990 MAXIMUM 1 MONTH	NO. MONTHS OVER OBJECTIVE 1988	1989	1990
29273 - OFIELD/HWY 5	*6.1	3.6	4.0	9.1	1	0	1
29074 - OFIELD S	4.8	4.4	3.8	6.2	1	0	0
29076 - MELDRUM/WESITE	5.2	5.3	4.5	6.9	3	3	0
29096 - OFIELD N	6.6	6.1	3.8	9.5	5	3	1
29097 - 4TH CONCESSION	3.4	4.7	3.6	7.4	1	1	1

* 9 months of data

FIGURE 19
Map of Sampling Station Locations
Near Steetley Industries
Flamborough

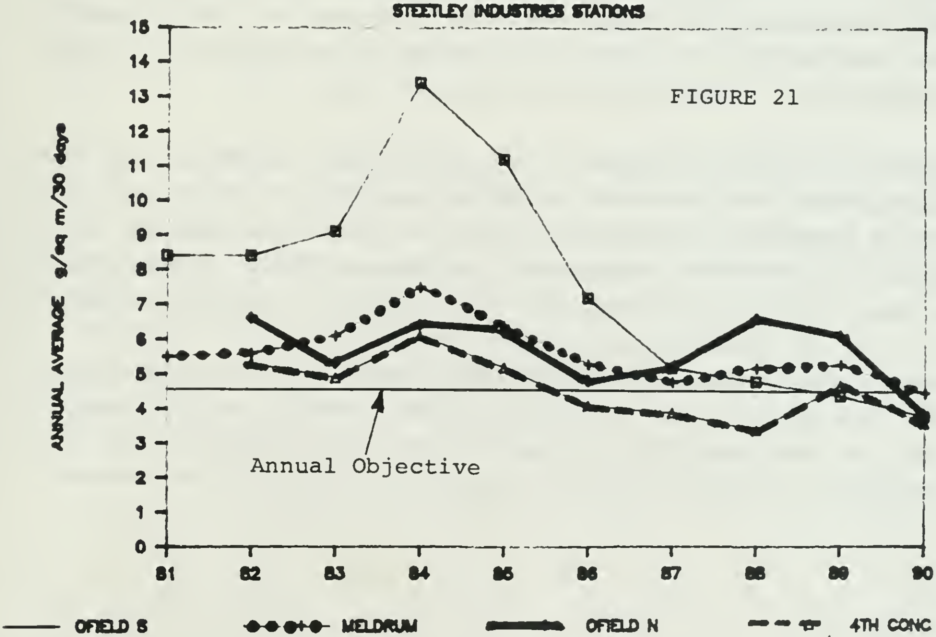
SUSPENDED PARTICULATE TREND

STEETLEY INDUSTRIES STATIONS



DUSTFALL TRENDS

STEETLEY INDUSTRIES STATIONS



6. DISCUSSION

There are two main air pollution problems in Hamilton, apart from occasional odours and dust fallout in the industrial area. One problem is short-term pollution build-ups during the spring and fall due to the presence of temperature inversions. The sources of this pollution are both vehicle traffic and industry.

The other problem is high ozone levels in summer, due to long range transport of pollutants. Ozone levels again exceeded objectives in 1990. As a long range pollution transport problem, it is being dealt with on a provincial, national and international basis. Nitrogen oxides/volatile organic contaminant control strategies are being implemented in both Canada and the United States. The year 2005 has been targeted to eliminate the ozone problem.

During 1990, suspended particulate levels decreased by 20% on average. The Air Pollution Index (API) reached the advisory level of 32 on two occasions during inversion conditions. The city's unique topography makes it very susceptible to inversions, during which times pollution build-ups are unavoidable, and therefore, such incidents will recur in the future. The frequency of these incidents is in decline however.

Dustfall levels throughout the city were unchanged at most locations in 1990 but were still well below pre-1987 levels. In 1987 a significant improvement occurred. No single initiative can be ascribed to this improvement. However, efforts by industry to control point sources and fugitive sources by such techniques as the use of chemical sealants, road paving, road washing and landscaping, together with improved street cleaning practices by the City may help to explain the trend. Further efforts must be made wherever possible. These can be both industrial and non-industrial in nature, such as controlling blow-off from unpaved

areas, excavation, construction, demolition, road traffic and stock piles and related materials handling. Further controls on industrial point sources will also continue where necessary.

The Hamilton air monitoring network has been expanded in recent years because of the introduction of the new Air Quality Index (AQI) in June, 1988.

A new telemetry system allows for immediate access to data, both in Toronto and in the Hamilton office and permits remote control and maintenance of instruments, all resulting in a more efficient monitoring program.

The AQI is a function of six different pollutants which form up to eight separate subindices. The highest hourly subindex becomes the AQI. Concentrations of sulphur dioxide, soiling index, carbon monoxide, nitrogen dioxide, total reduced sulphur and ozone are all individually converted to the old scale of index numbers (although not all AQI stations measure all six pollutants and eight subindices). The advisory or alert levels remain the same as previously 32, 50, 75, and 100. The old Air Pollution Index (API) has been retained as one subindex and will continue to be used for industrial action requests should the API reach or exceed 32.

In Hamilton, four separate AQIs are being reported for the east, west, mountain and the new downtown station at Elgin/Kelly. The need for more than one index station in Hamilton had been apparent for some time as air quality can vary widely throughout the city at any given time.

The intent of the new index is to better inform the community about day to day air quality.

7. References

1. Ontario Ministry of the Environment, July 1990. "1988 Hamilton Air Quality". Frank Dobroff, West Central Region, Hamilton, Ontario.

2. U.S. Environmental Protection Agency. Office of Research and Development, December 1977. "Research Highlights 1977". Report No. 600/9-77-044. Washington, D.C.

3. Ontario Ministry of Labour, Fall 1983 Report. "Assessment of Fluoride Exposure in Populations Residing Close to Fluoride Emitting Brick Plants".

4. Ontario Ministry of the Environment, June 1987. "Evaluation of a New Filter Medium for High Volume Sampling ". Report ISBN 0-7729-2639-5.

5. Canadian Council of Ministers of the Environment, November 1990 "Management Plan for Nitrogen Oxides and Volatile Organic Compounds" Phase I, Summary Report.

APPENDIX

TECHNICAL ASSESSMENT SECTION

AIR RESOURCES UNIT

WEST CENTRAL REGION

May, 1991

HAMILTON AIR QUALITY DURING THE STELCO STRIKE AUGUST - NOVEMBER, 1990

From August 1 to mid-November 1990, Stelco Steel's Hilton Works was on strike, resulting in a shutdown of most of its operations, allowing for a opportunity to observe the effect on Hamilton air quality. It should be noted, however, that some major operations had to continue, e.g. coking.

Methodology

The pollutants studied were:

- sulphur dioxide (SO_2) - six stations
- total reduced sulphur (TRS) - five stations
- carbon monoxide (CO) - one station
- reactive hydrocarbons (RHC) - one station
- nitrogen dioxide (NO_2) - four stations
- nitric oxide (NO) - four stations
- nitrogen oxide (NOx) - four stations
- soiling index (COH) - five stations
- suspended particulates (TSP) - 18 stations
- carbon in TSP - four stations
- iron and manganese in TSP - seven stations
- dustfall - 17 stations
- fluoride - 10 stations

A map of station locations is given in Figure 1.

The end of the strike was inexact as operations were slow to recommence in November. For simplicity, the months of August, September and October were compared to the same months in 1987 to 1989. Seasonal fluctuations preclude comparisons to other time periods.

With the exception of the monthly fluoride and dustfall results, the strike effect was determined both on an overall basis (i.e. all the data) and on the downwind case, i.e. those samples or hours where the monitoring station would have been downwind of Stelco.

To determine the downwind averages, the pollution rose program was utilized for the continuous parameters. Averages for specific wind sectors, (e.g. NE, NNE etc.) were selected depending on the station's location in relation to Stelco. For the suspended particulate results, this analysis could not be as precise. For the bulk of the city's stations, northeast or east wind days were selected while west wind days were compared for the Beach Strip.

For the overall average comparisons, attempts were made at normalizing results in case of widely disparate weather conditions, particularly critical wind frequencies and rainfall. However, weather variations from year to year were relatively minor and corrections were not necessary.

Results

Percentage decreases due to the strike for all contaminants are summarized in Table 1 and illustrated in Figures 2 - 5.

Sulphur Dioxide (SO_2) - Figures 6 and 7

The 1988/89 combined average (3 month period) was compared to the strike for each of six stations.

From Table 1, downwind decreases were fairly large, up to 61% .

The overall change was equally large at a couple of locations closest to Stelco but the median drop was only 17%.

Sulphur dioxide levels are generally low in Hamilton, so these decreases were not large in absolute magnitude.

Total Reduced Sulphur (TRS) - Figures 8 and 9

As for SO_2 and the other continuous parameters, the 1988-89 combined three month averages were compared to the strike for each of 5 stations.

From Table 1, large downwind decreases of up to 84% were observed. Overall drops were also large. TRS was one of the pollutants to show the most significant effects.

Carbon Monoxide (CO) - Figures 10 and 11

A significant downwind decrease of 29% was observed at one station (29000 - Elgin/Kelly), but overall there was no effect.

CO levels in Hamilton are very low, so any change would be marginal.

Reactive Hydrocarbons (RHC) - Figures 10 and 11

The downwind effect was large (39%) at one station, 29000 - Elgin/Kelly. Overall, the drop was small. The exact composition of these hydrocarbons is unknown leaving the significance of these decreases in question.

Nitrogen Dioxide (NO_2) - Figures 12 and 13

Downwind decreases were large, up to 47%. Overall, the drops were generally small.

Nitric Oxide (NO) - Figures 14 and 15

Results were similar to NO_2 for the downwind case, but overall the decreases were larger, with a median of 30%. The overall median decrease was actually higher than the downwind median. Other sources such as traffic may have been a factor.

Nitrogen Oxides (NOx) - Figures 16 and 17

Results were similar to NO, largely because NO dominates this measurement. NOx is the sum of NO and NO_2. NOx levels in Hamilton are normally low, although elevated levels in the industrial zone have been observed during mobile surveys.

Soiling Index (COH) - Figures 18 and 19

Large downwind decreases of up to 61% and a median of 44% were observed. One location, the Hamilton East AQI was unaffected. The overall effect was significant as well (24% median).

Suspended Particulates (TSP) - Figures 20 -23

Figures 20 and 21 illustrate overall strike averages at the 18 hivol stations compared to the same months in 1987, 1988 and 1989. Those three latter periods were averaged (weighted geometric mean) and compared to the strike means.

Table 1 summarizes the decreases. The overall changes were very small. Only three of the 18 stations showed appreciable decreases over 20% while all others ranged from 0 to 7%. The three stations were: 29011 - Burlington/Leeds, 29102 - Beach Blvd. and 29124/128 - Buchanan Park (mountain). The latter station's 1987-89 mean was hindered by few 1987 and 1988 data. This "decrease " may be an anomaly.

The "downwind" data were simply considered to be those days of

northeast or east wind conditions for the main part of the city (17 stations) and west wind days for the one Beach strip station. There were five downwind dates during the strike for the group of 17 and four downwind dates for the Beach Strip station. These were then compared to similar downwind dates in 1987 to 1989. The latter three years were combined into a single weighted geometric mean since sample size was small in individual years. Figures 22 and 23 illustrate the downwind effect at each individual station. Table 1 shows large effects of up to 50% (measured at 29011 - Burlington/Leeds). The median drop was 29%.

<u>Free and Total Carbon in TSP - Figures 24-27</u>

Carbon is monitored at four hivol stations. Analysis is similar to that for TSP.

Overall (Figures 24 and 25), free carbon decreased hardly at all, including near Stelco at Station 29011. Total carbon did show decreases up to 22% at the Beach Strip.

The downwind decreases (Figures 26 and 27) were significant, up to 35% for free carbon (at 29025 - Barton/Sanford), but moreso for total carbon, up to 46% (also at Barton).

<u>Iron and Manganese in TSP - Figure 27 - 31</u>

Metals are monitored for at seven hivol stations. Iron and manganese were chosen as they are indicative of steel industry emissions. Other metals such as lead and cadmium show little variation throughout the City, occur at background levels and would likely show little or no effect.

Overall decreases (Figures 28 and 29) for both iron and manganese were significant, up to 64 and 65% respectively, both at 29102 - Beach Blvd.

Downwind decreases (Figures 30 and 31), were very large for both iron and manganese, up to 90% and 76% respectively (both at 29067 - Hughson North). Median decreases were both over 50%.

Dustfall - Figure 32

Dustfall levels with only few exceptions showed little or no effect at 17 of 18 stations. Station 29011 - Burlington/Leeds, adjacent to Stelco did show a 31% decrease. Large particle fallout is obviously normally localized near the mill site. The lack of change at the other industrial zone stations such as 29010 and 29036 indicates the prevalence of other sources in the area.

Iron and Manganese in Dustfall - Figures 33 and 34

Metals are analyzed for at five dustfall stations, but do not include Station 29011. As a result, little change is apparent for either metal. One station, 29030 appears in the Figures to show a decrease during the strike, but the strike average is actually station 29230, remote from Mohawk Road. Data from the former two years was from Station 29030, immediately adjacent to traffic on Mohawk. Thus, the changes in levels are more related to the station move than the strike.

Fluoride - Figure 35

Fluoride levels showed significant decreases of up to 53% at 10 stations with a median of 43%. Only one station (29062) showed no effect of the strike, but this is due to its proximity to Hamilton Brick, the single largest fluoride source in the city. The largest decrease occurred at 29120, directly near Stelco.

Conclusions

The Stelco strike indicated that Stelco Steel is a major contributor to a number of pollutants in Hamilton. The pollutants

which showed the greatest impact, with the most significant effects were:

Total Reduced Sulphur
Soiling Index
Suspended Particulates (TSP)
Iron, Manganese, Total Carbon in TSP
Fluoride

F. Dobroff
July 3, 1991

TABLE 1

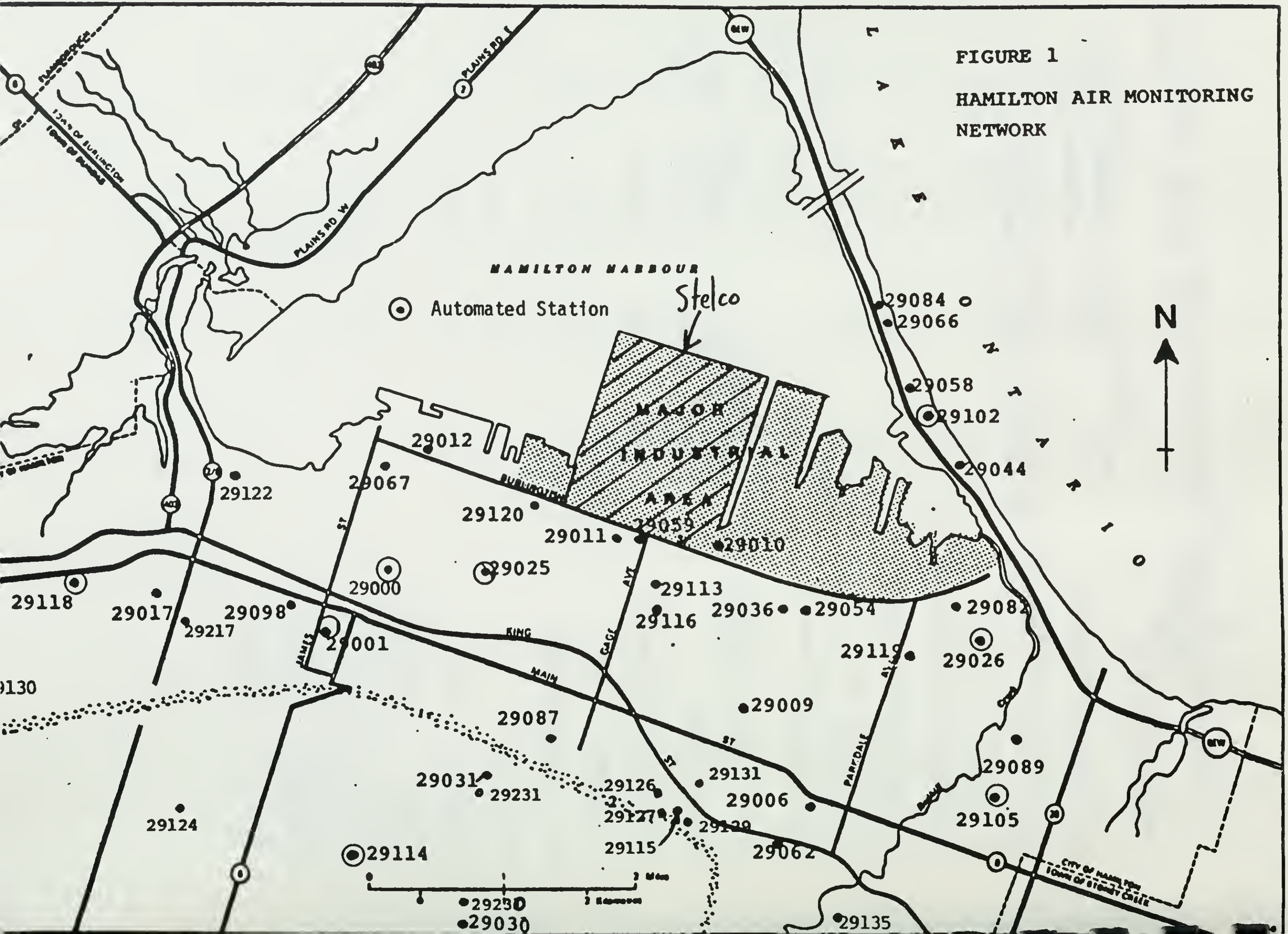
POLLUTANT DECREASES DURING STELCO STRIKE (AUG-OCT 1990)
(PERCENTS)

GASEOUS POLLUTANTS	DOWNWIND RANGE	DOWNWIND MEDIAN	OVERALL RANGE	OVERALL MEDIAN
SULPHUR DIOXIDE (SO2) (6 stations)	0-61	48	0-56	17
TOTAL REDUCED SULPHUR (TRS) (5 stations)	25-84	60	20-62	50
CARBON MONOXIDE (CO) (1 station)	29	-	0	
REACTIVE HYDROCARBONS (RHC) (1 station)	39		13	
NITROGEN DIOXIDE (NO2) (4 stations)	14-47	25	6-31	9
NITRIC OXIDE (NO) (4 stations)	3-64	24	13-52	30
NITROGEN OXIDES (NOx) (4 stations)	14-57	23	13-28	25

PARTICULATES & FLUORIDE	DOWNWIND RANGE	DOWNWIND MEDIAN	OVERALL RANGE	OVERALL MEDIAN
SOILING INDEX (7 stations)	0-61	44	0-39	24
SUSPENDED PARTICULATES (18 stations)	12-50	29	0-26	2
FREE CARBON IN TSP (4 stations)	9-35	18	0-3	0
TOTAL CARBON IN TSP (4 stations)	3-46	34	4-22	13
IRON IN TSP (7 stations)	37-90	52	21-64	27
MANGANESE IN TSP (7 stations)	26-76	61	5-65	29
DUSTFALL (16 stations)			0	
DUSTFALL (1 station)			31	
IRON IN DUSTFALL (5 stations)			0-12	0
MANGANESE IN DUSTFALL (5 stations)			0-6	0
FLUORIDE (10 stations)			0-53	43

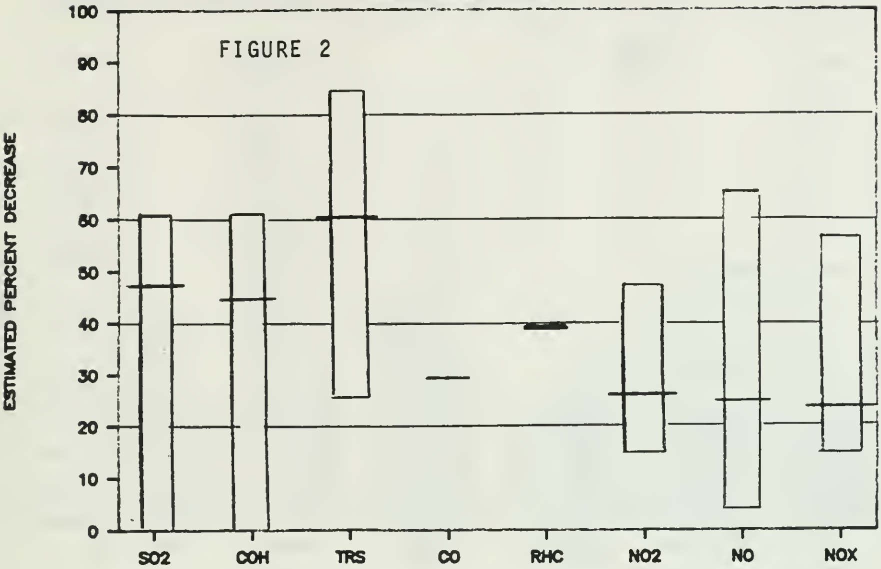
FIGURE 1

HAMILTON AIR MONITORING NETWORK



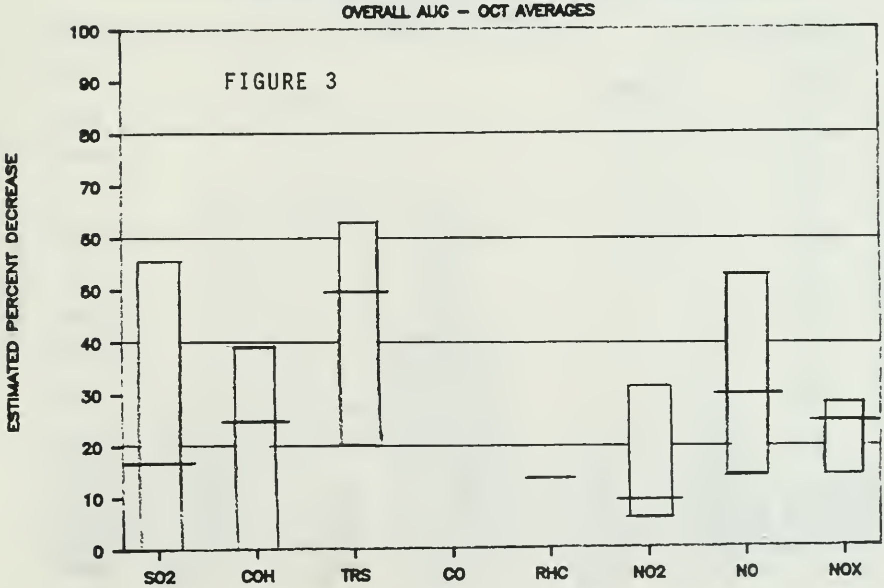
ESTIMATED STRIKE DECREASE BY POLLUTANT

CRITICAL WIND DATA ONLY



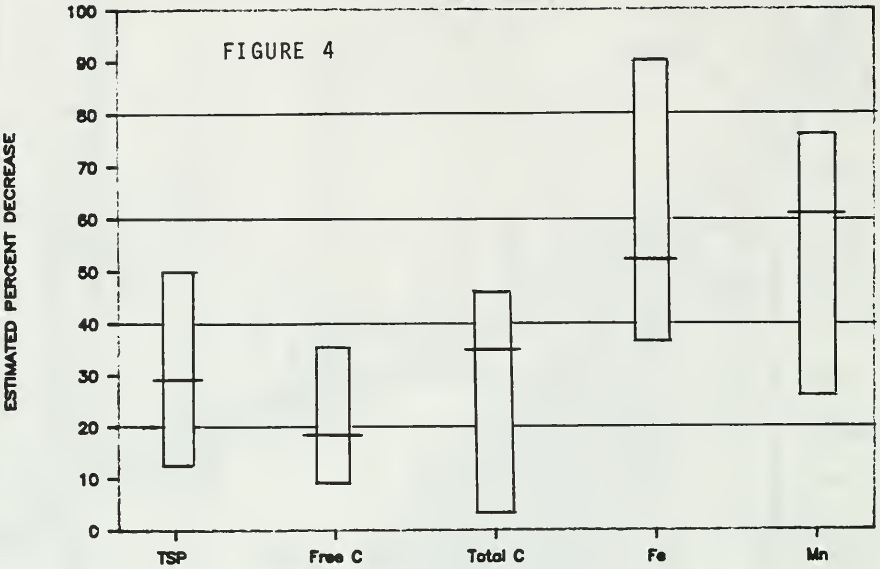
ESTIMATED STRIKE DECREASE BY POLLUTANT

OVERALL AUG – OCT AVERAGES



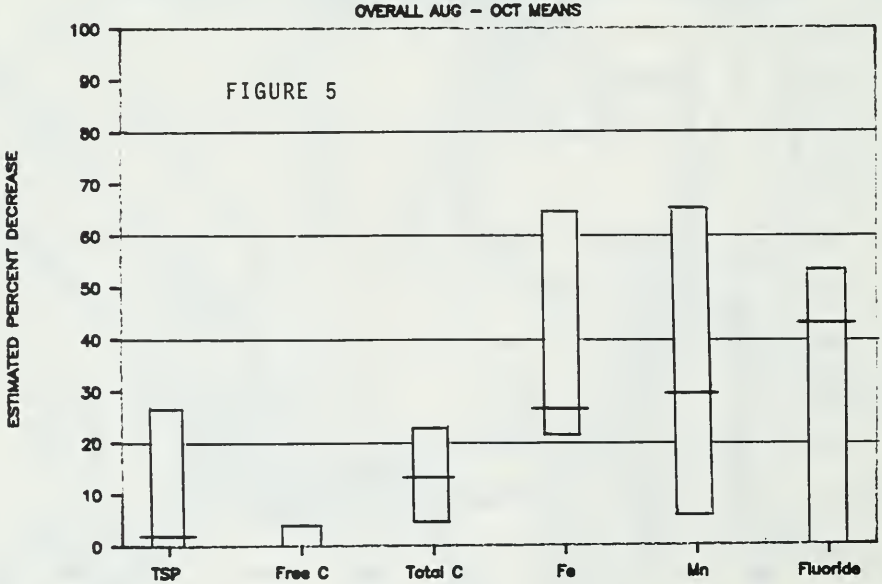
ESTIMATED STRIKE DECREASE BY POLLUTANT

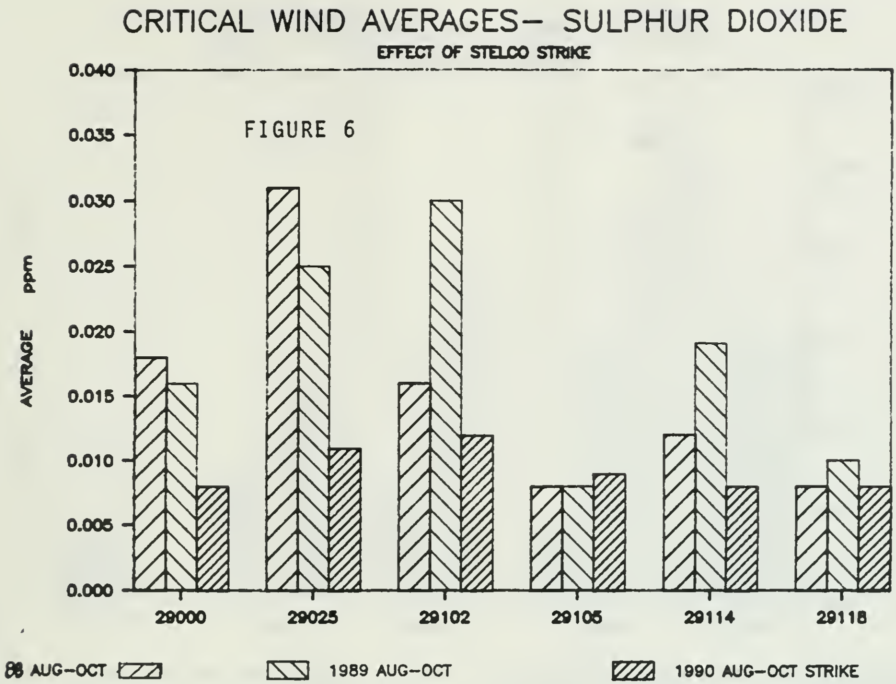
CRITICAL WIND DATA ONLY

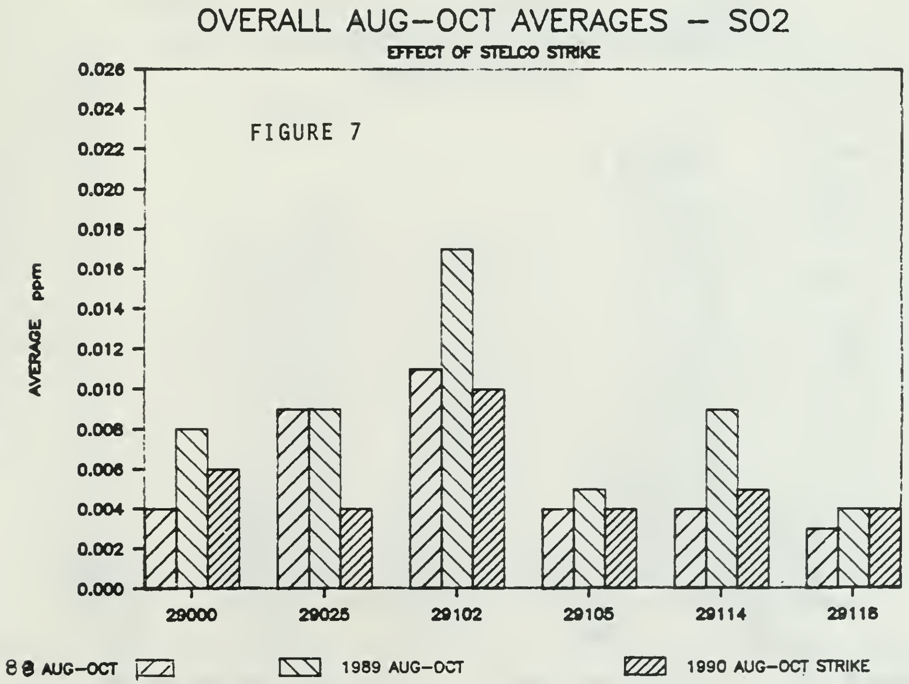


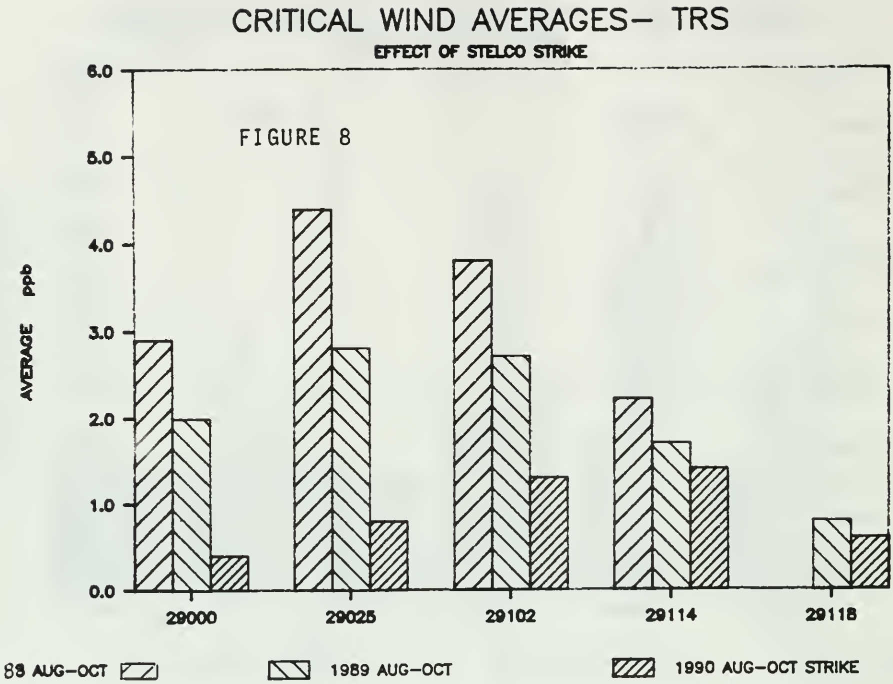
ESTIMATED STRIKE DECREASE BY POLLUTANT

OVERALL AUG – OCT MEANS

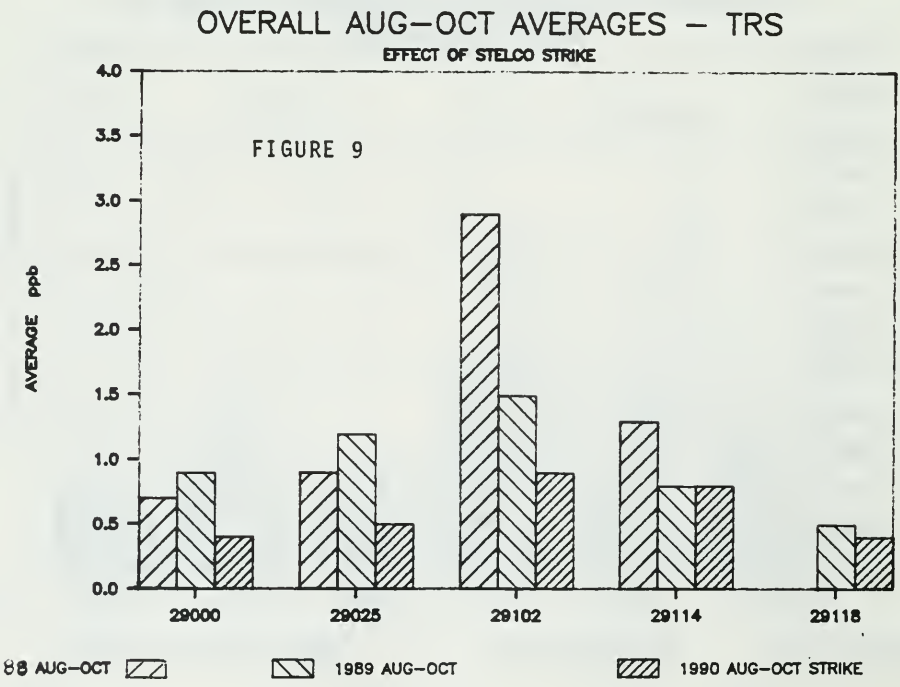



CRITICAL WIND AVERAGES– SULPHUR DIOXIDE
EFFECT OF STELCO STRIKE
FIGURE 6
AVERAGE ppm
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
29000
29025
29102
29105
29114
29118
88 AUG–OCT
1989 AUG–OCT
1990 AUG–OCT STRIKE


OVERALL AUG–OCT AVERAGES – SO2
EFFECT OF STELCO STRIKE
FIGURE 7
AVERAGE ppm
0.026
0.024
0.022
0.020
0.018
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
29000
29025
29102
29105
29114
29118
88 AUG–OCT
1989 AUG–OCT
1990 AUG–OCT STRIKE



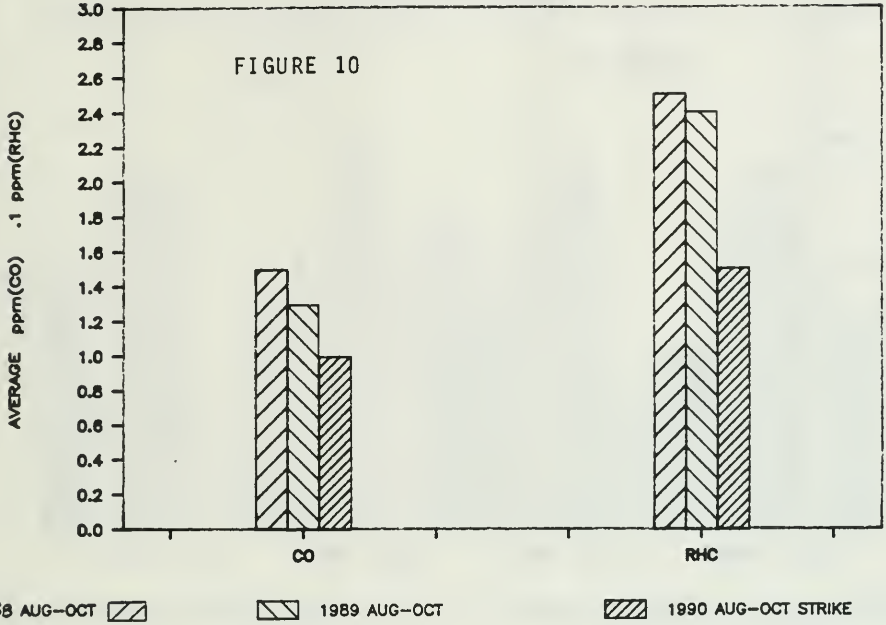
CRITICAL WIND AVERAGES– TRS
EFFECT OF STELCO STRIKE
FIGURE 8
AVERAGE ppb
0.0
1.0
2.0
3.0
4.0
5.0
6.0
29000
29025
29102
29114
29118
88 AUG–OCT
1989 AUG–OCT
1990 AUG–OCT STRIKE



OVERALL AUG–OCT AVERAGES – TRS
EFFECT OF STELCO STRIKE
FIGURE 9
AVERAGE ppb
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
29000
29025
29102
29114
29118
88 AUG–OCT
1989 AUG–OCT
1990 AUG–OCT STRIKE

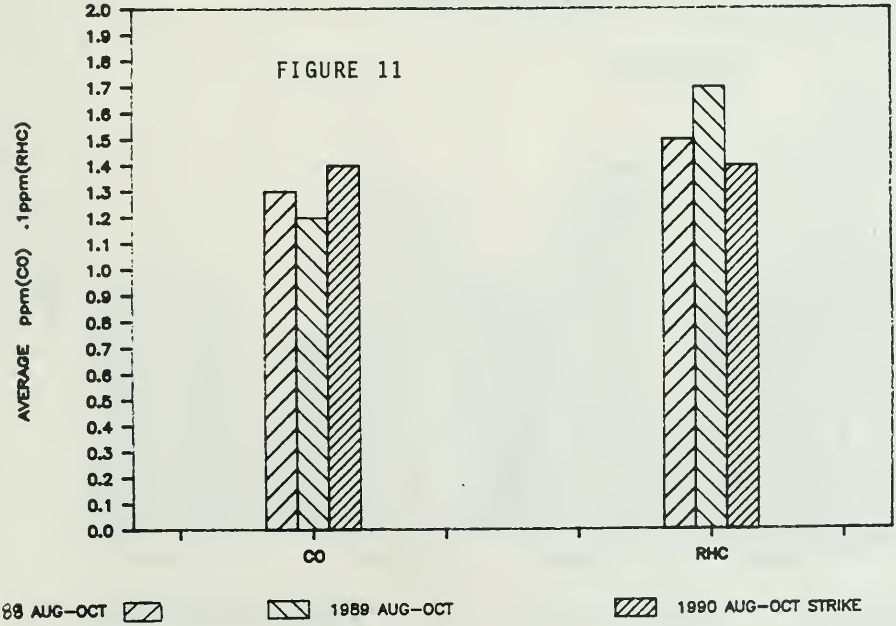
CRITICAL WIND AVGS— CO & RHC AT 29000

EFFECT OF STELCO STRIKE



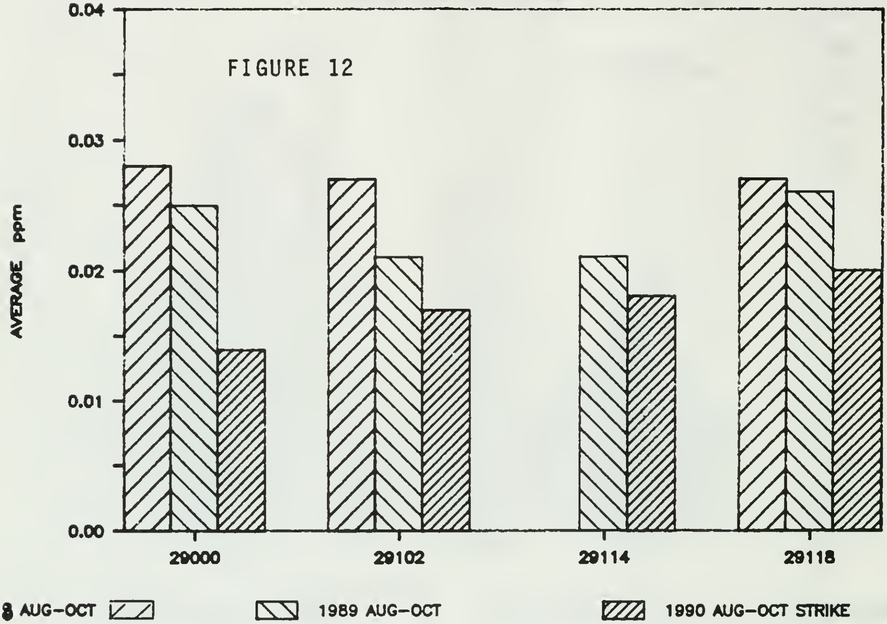
OVERALL AUG-OCT AVERAGES AT 29000

EFFECT OF STELCO STRIKE



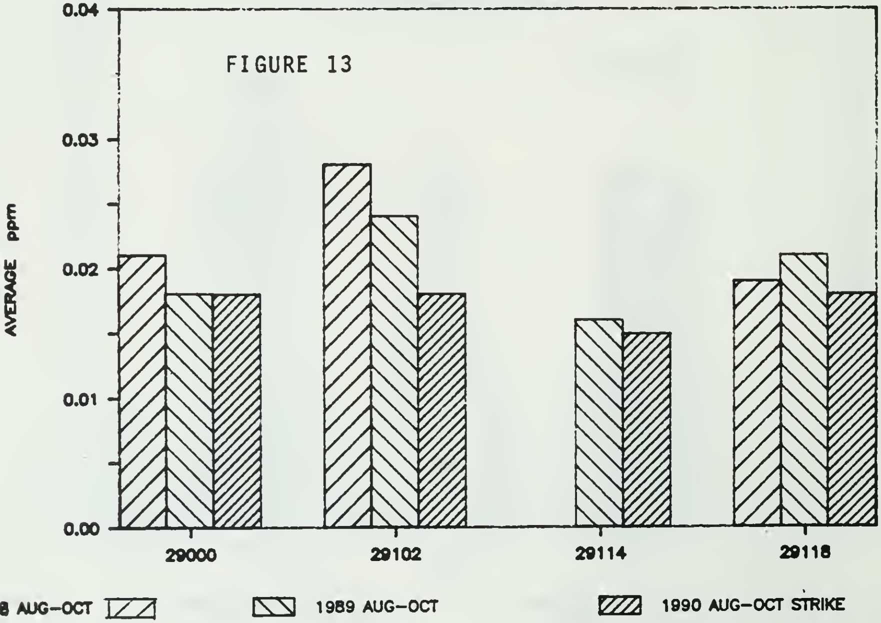
CRITICAL WIND AVERAGES– NO2

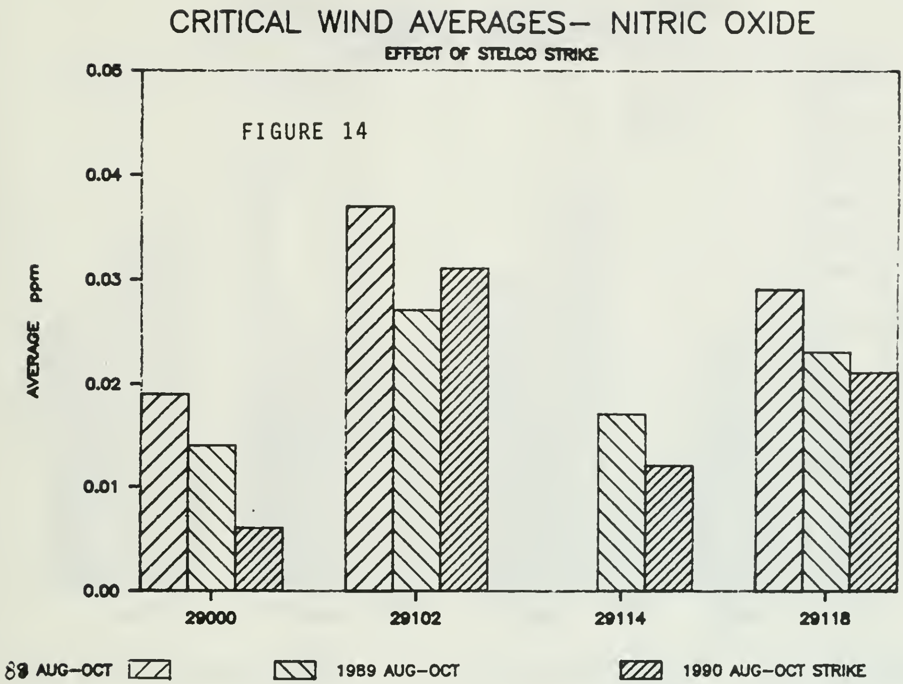
EFFECT OF STELCO STRIKE

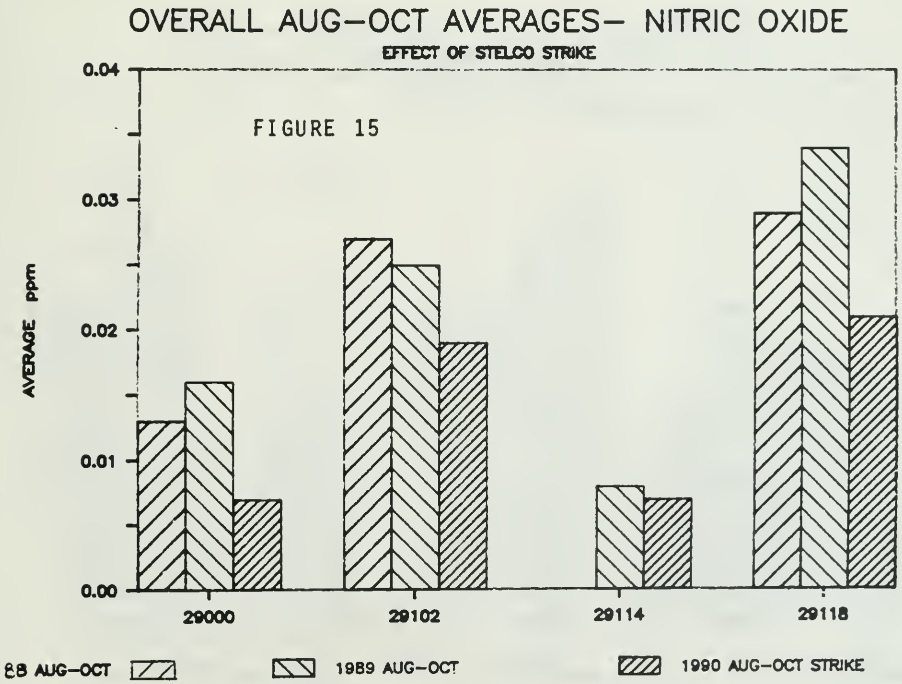


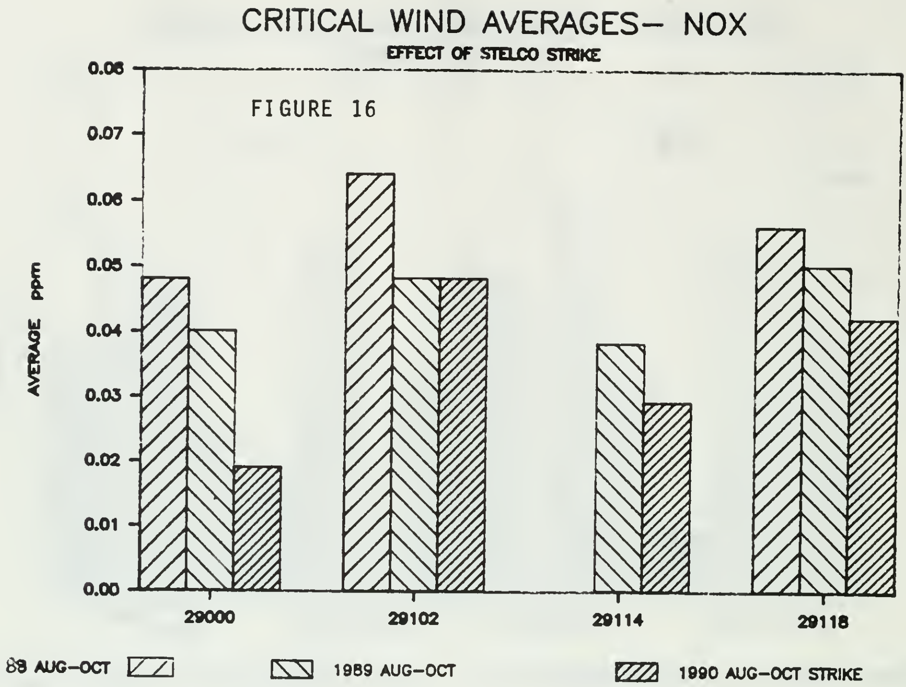
OVERALL AUG–OCT AVERAGES– NO2

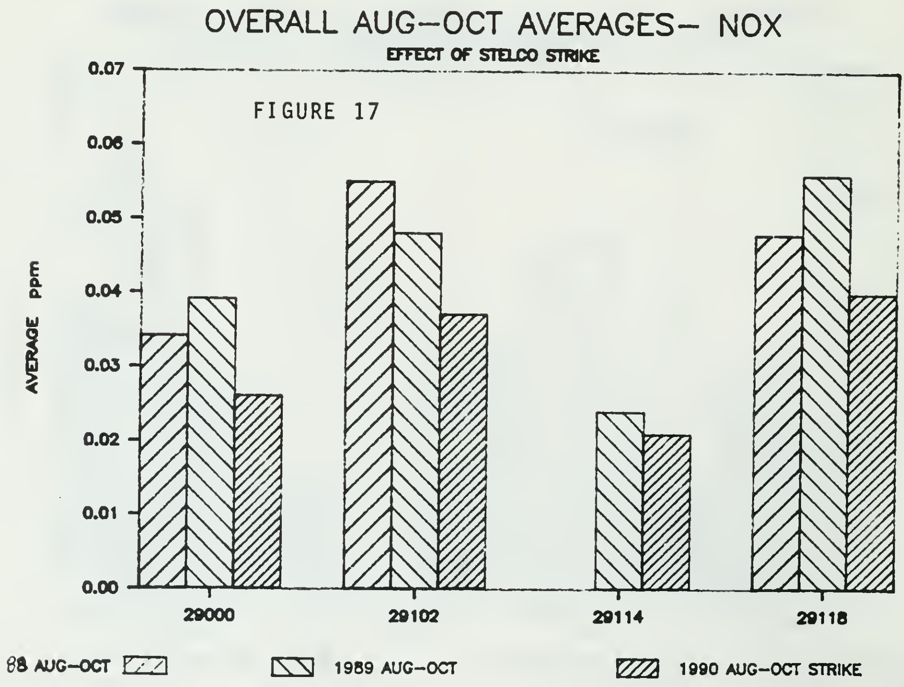
EFFECT OF STELCO STRIKE

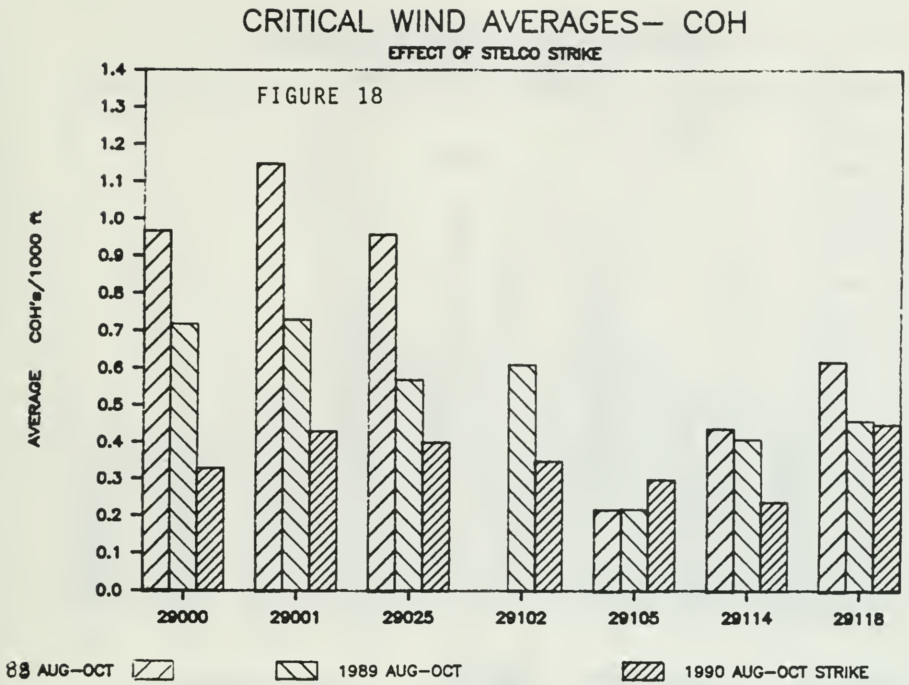


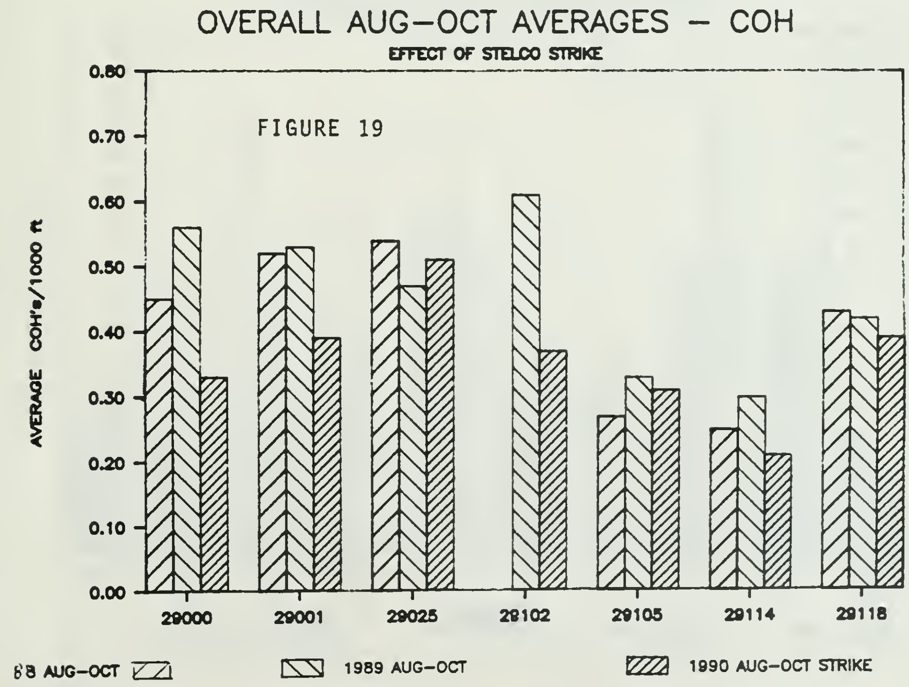

CRITICAL WIND AVERAGES– NITRIC OXIDE
EFFECT OF STELCO STRIKE
FIGURE 14
AVERAGE ppm
0.05
0.04
0.03
0.02
0.01
0.00
29000
29102
29114
29118
89 AUG-OCT
1989 AUG-OCT
1990 AUG-OCT STRIKE

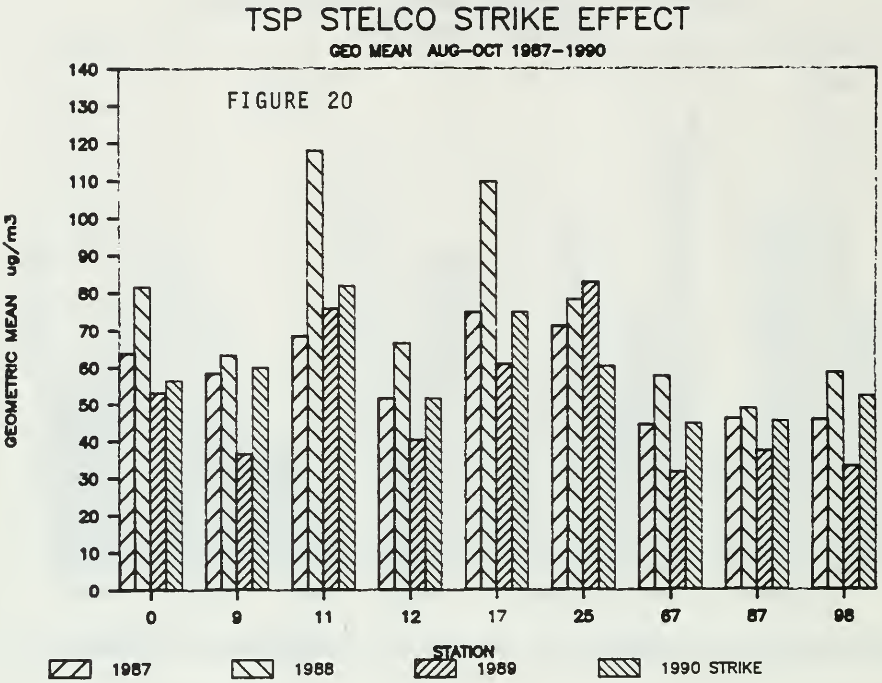

OVERALL AUG-OCT AVERAGES– NITRIC OXIDE
EFFECT OF STELCO STRIKE
FIGURE 15
AVERAGE ppm
0.04
0.03
0.02
0.01
0.00
29000
29102
29114
29118
88 AUG-OCT
1989 AUG-OCT
1990 AUG-OCT STRIKE


CRITICAL WIND AVERAGES– NOX
EFFECT OF STELCO STRIKE
FIGURE 16
AVERAGE ppm
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
29000
29102
29114
29118
88 AUG-OCT
1989 AUG-OCT
1990 AUG-OCT STRIKE

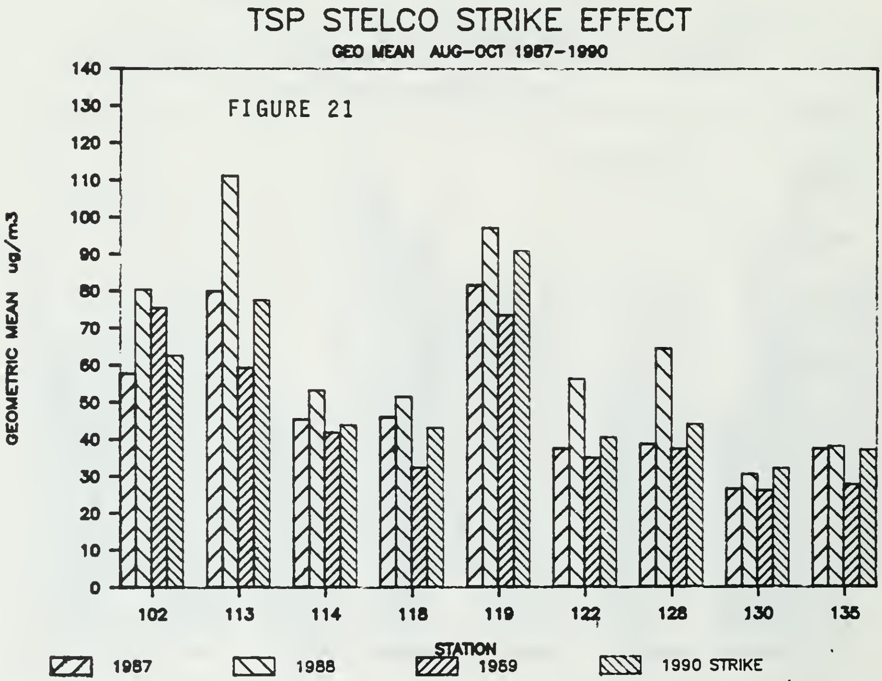

OVERALL AUG-OCT AVERAGES– NOX
EFFECT OF STELCO STRIKE
FIGURE 17
AVERAGE ppm
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
29000
29102
29114
29118
88 AUG-OCT
1989 AUG-OCT
1990 AUG-OCT STRIKE


CRITICAL WIND AVERAGES- COH
EFFECT OF STELCO STRIKE
FIGURE 18
AVERAGE COH's/1000 ft
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
29000
29001
29025
29102
29105
29114
29118
88 AUG-OCT
1989 AUG-OCT
1990 AUG-OCT STRIKE

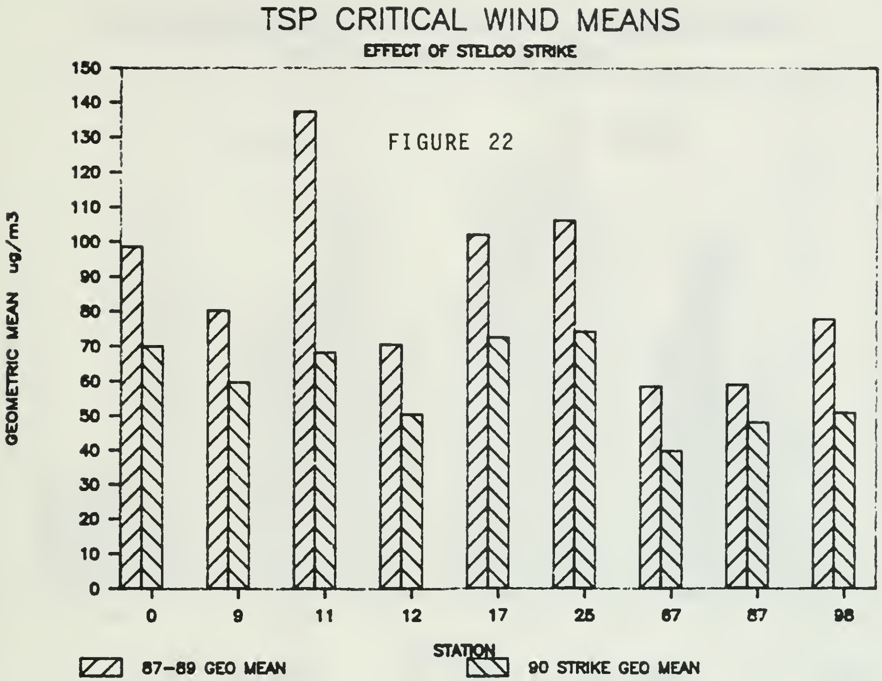

OVERALL AUG-OCT AVERAGES - COH
EFFECT OF STELCO STRIKE
FIGURE 19
AVERAGE COH's/1000 ft
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
29000
29001
29025
29102
29105
29114
29118
88 AUG-OCT
1989 AUG-OCT
1990 AUG-OCT STRIKE

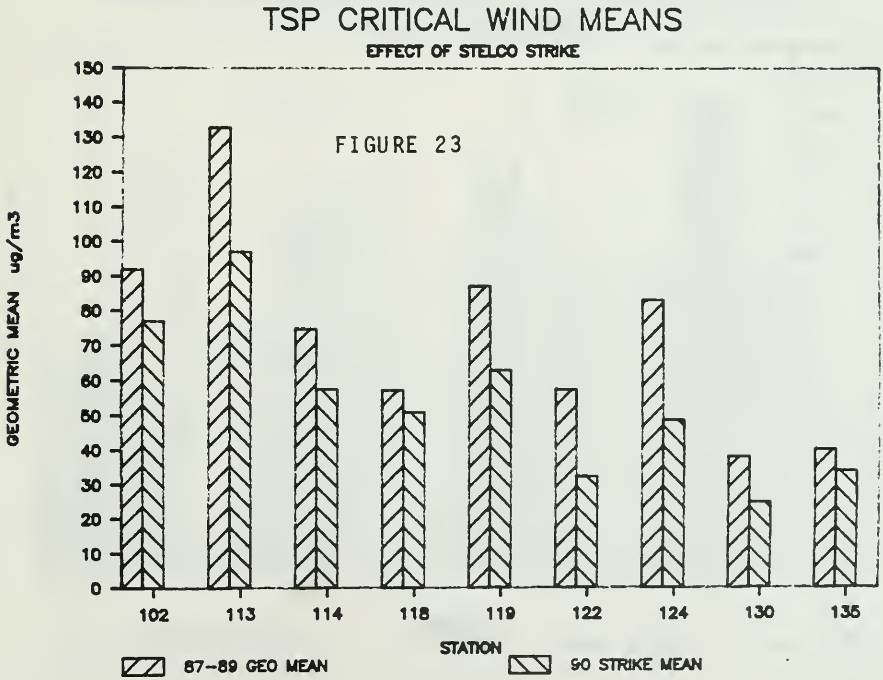


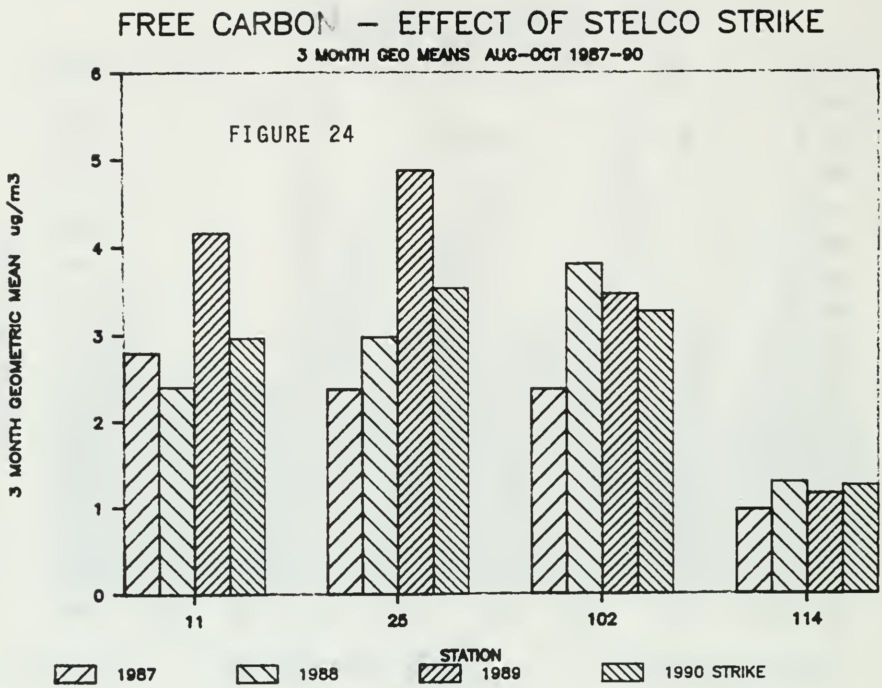
TSP STELCO STRIKE EFFECT
GEO MEAN AUG-OCT 1987-1990
FIGURE 20
GEOMETRIC MEAN ug/m3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
0
9
11
12
17
25
67
87
98
STATION
1987
1988
1989
1990 STRIKE

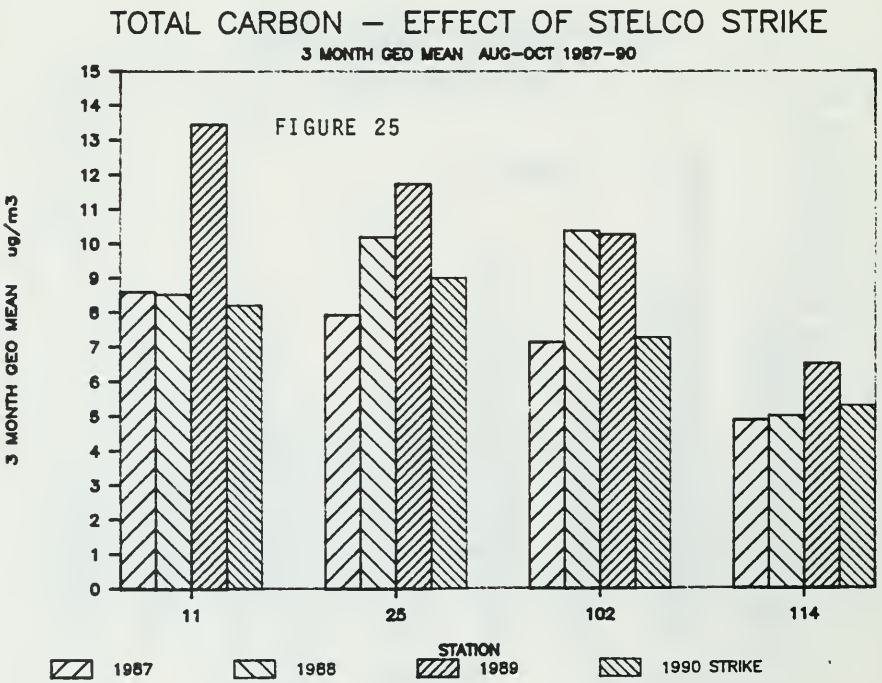


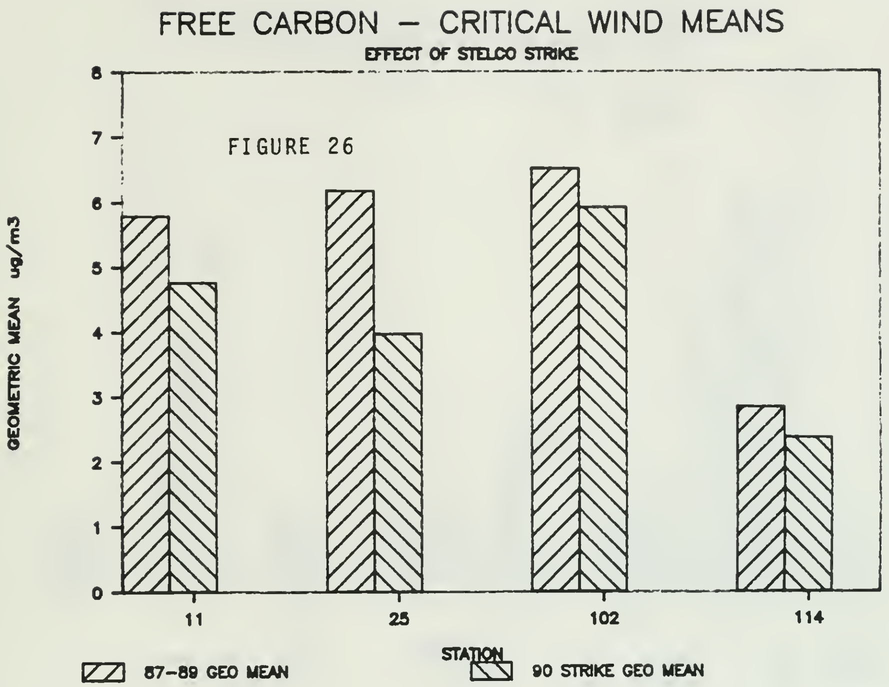
TSP STELCO STRIKE EFFECT
GEO MEAN AUG-OCT 1987-1990
FIGURE 21
GEOMETRIC MEAN ug/m3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
102
113
114
118
119
122
128
130
135
STATION
1987
1988
1989
1990 STRIKE

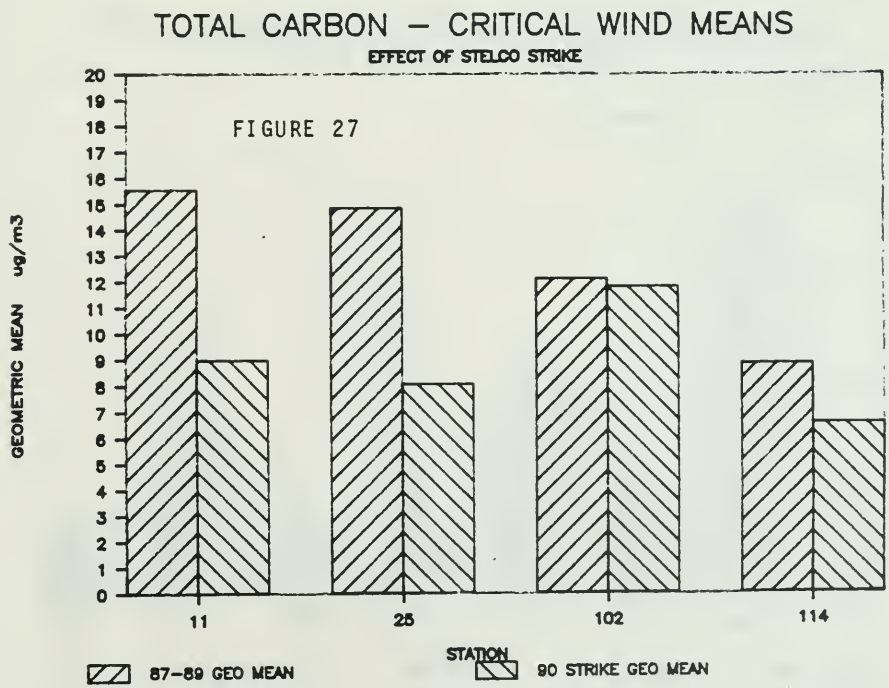

TSP CRITICAL WIND MEANS
EFFECT OF STELCO STRIKE
FIGURE 22
GEOMETRIC MEAN ug/m3
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
9
11
12
17
25
67
87
98
STATION
87-89 GEO MEAN
90 STRIKE GEO MEAN


TSP CRITICAL WIND MEANS
EFFECT OF STELCO STRIKE
FIGURE 23
GEOMETRIC MEAN ug/m3
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
102
113
114
118
119
122
124
130
135
STATION
87-89 GEO MEAN
90 STRIKE MEAN


FREE CARBON - EFFECT OF STELCO STRIKE
3 MONTH GEO MEANS AUG-OCT 1987-90
FIGURE 24
3 MONTH GEOMETRIC MEAN ug/m3
0
1
2
3
4
5
6
11
25
102
114
STATION
1987
1988
1989
1990 STRIKE

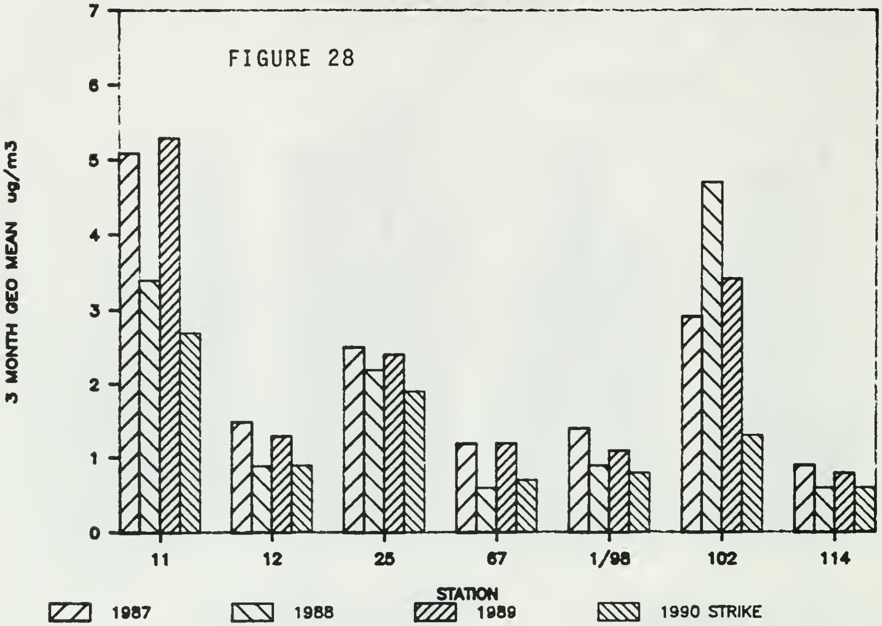

TOTAL CARBON - EFFECT OF STELCO STRIKE
3 MONTH GEO MEAN AUG-OCT 1987-90
FIGURE 25
3 MONTH GEO MEAN ug/m3
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
11
25
102
114
STATION
1987
1988
1989
1990 STRIKE


FREE CARBON – CRITICAL WIND MEANS
EFFECT OF STELCO STRIKE
FIGURE 26
GEOMETRIC MEAN ug/m3
0
1
2
3
4
5
6
7
8
11
25
102
114
STATION
87-89 GEO MEAN
90 STRIKE GEO MEAN


TOTAL CARBON – CRITICAL WIND MEANS
EFFECT OF STELCO STRIKE
FIGURE 27
GEOMETRIC MEAN ug/m3
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
11
25
102
114
STATION
87-89 GEO MEAN
90 STRIKE GEO MEAN

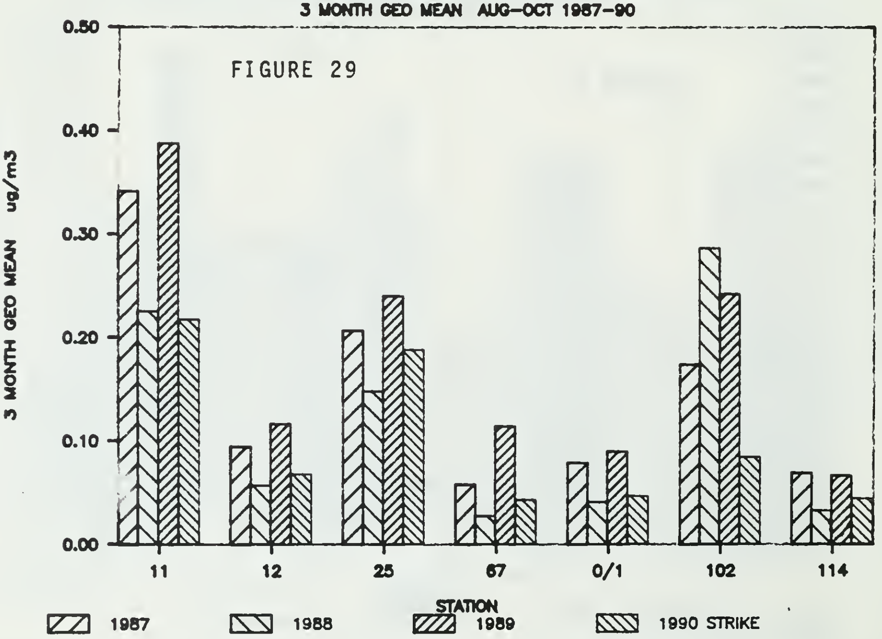
IRON (TSP) - EFFECT OF STELCO STRIKE

3 MONTH GEO MEAN AUG-OCT 1987-90



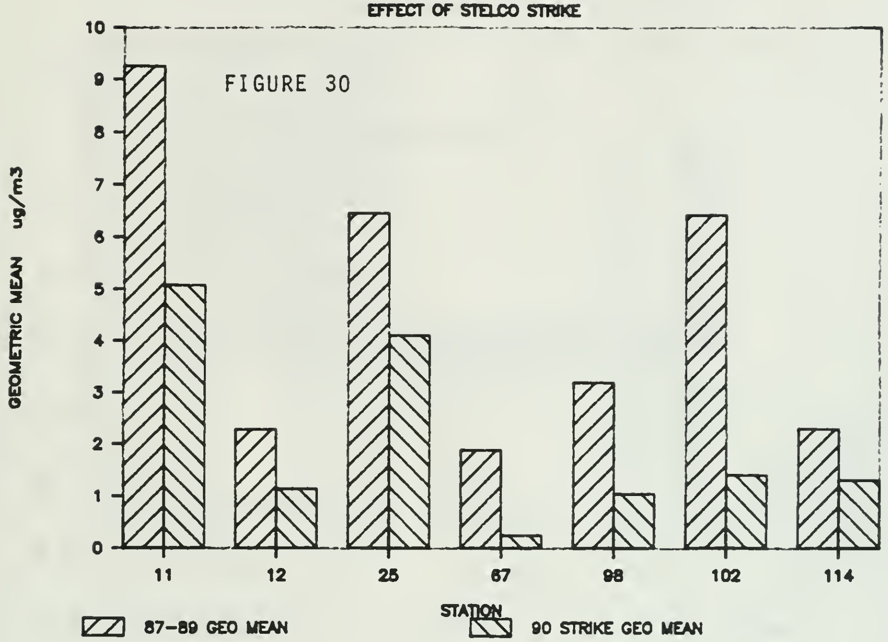
MANGANESE(TSP)- EFFECT OF STELCO STRIKE

3 MONTH GEO MEAN AUG-OCT 1987-90



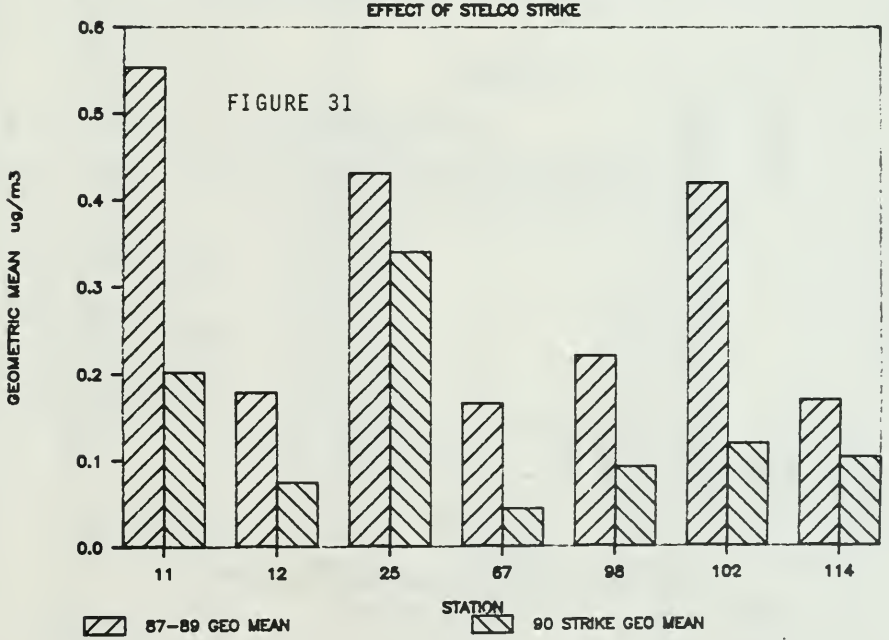
IRON(TSP) CRITICAL WIND MEANS

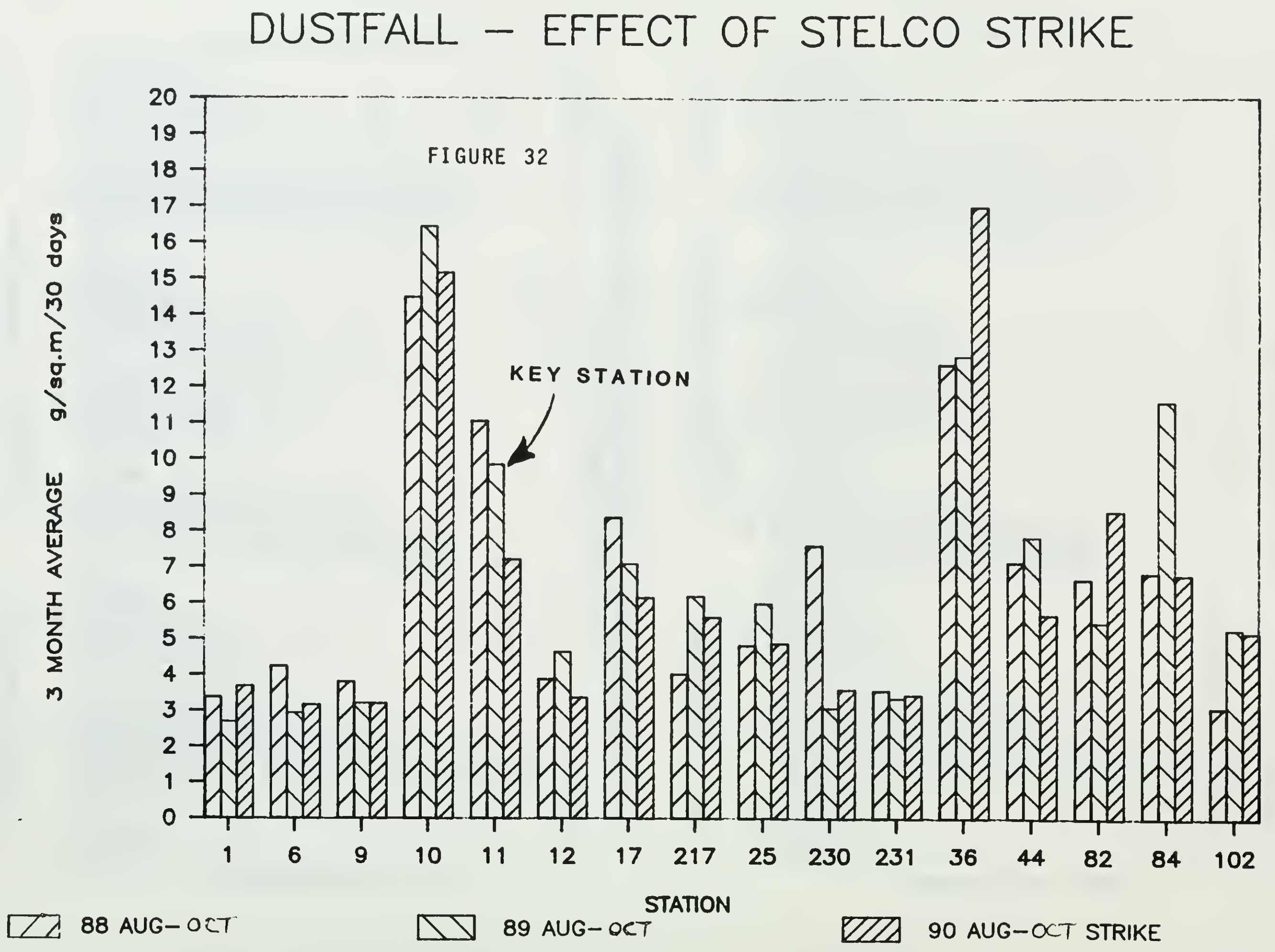
EFFECT OF STELCO STRIKE



MANGANESE(TSP) CRITICAL WIND MEANS

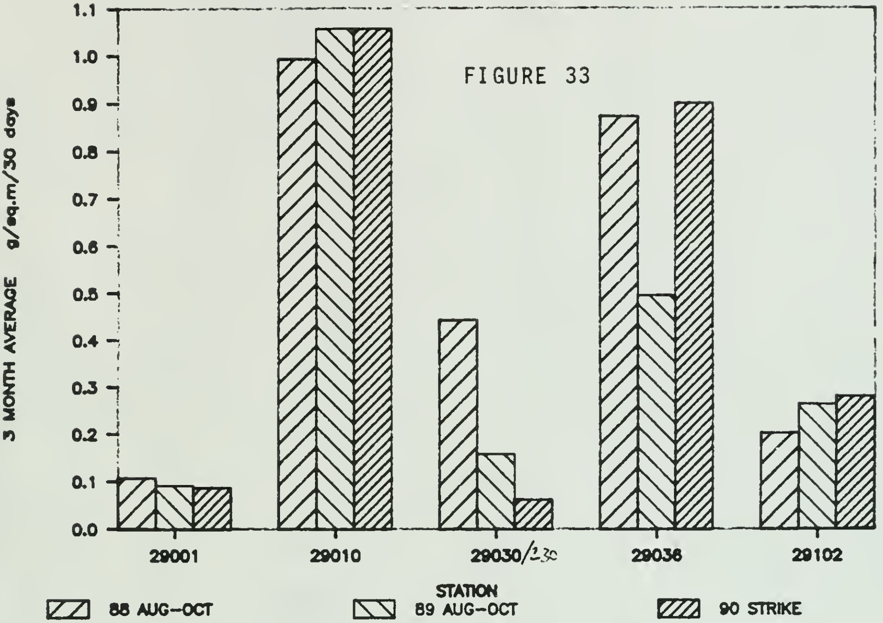
EFFECT OF STELCO STRIKE




DUSTFALL — EFFECT OF STELCO STRIKE
FIGURE 32
KEY STATION
3 MONTH AVERAGE g/sq.m/30 days
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
1 6 9 10 11 12 17 217 25 230 231 36 44 82 84 102
STATION
88 AUG-OCT
89 AUG-OCT
90 AUG-OCT STRIKE

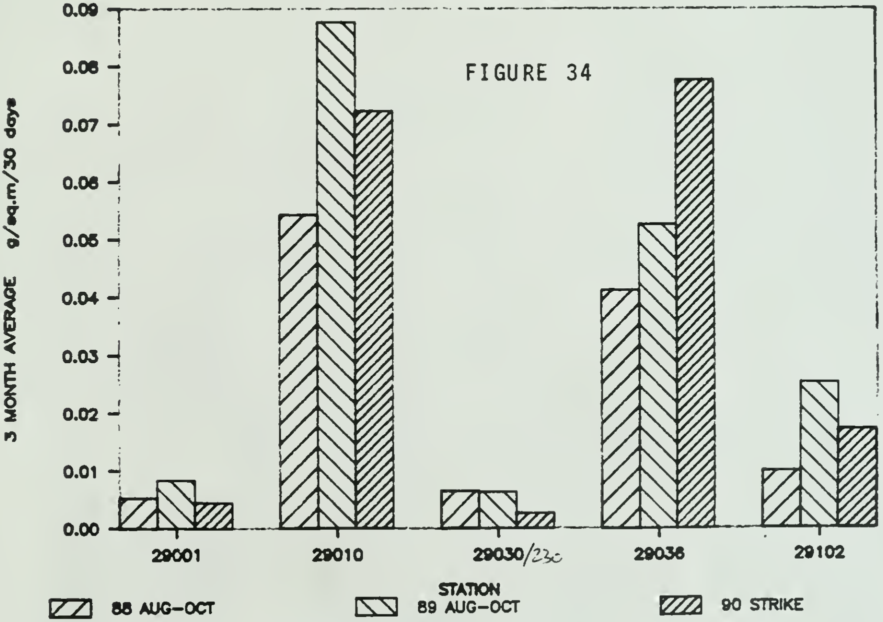
IRON IN DUSTFALL

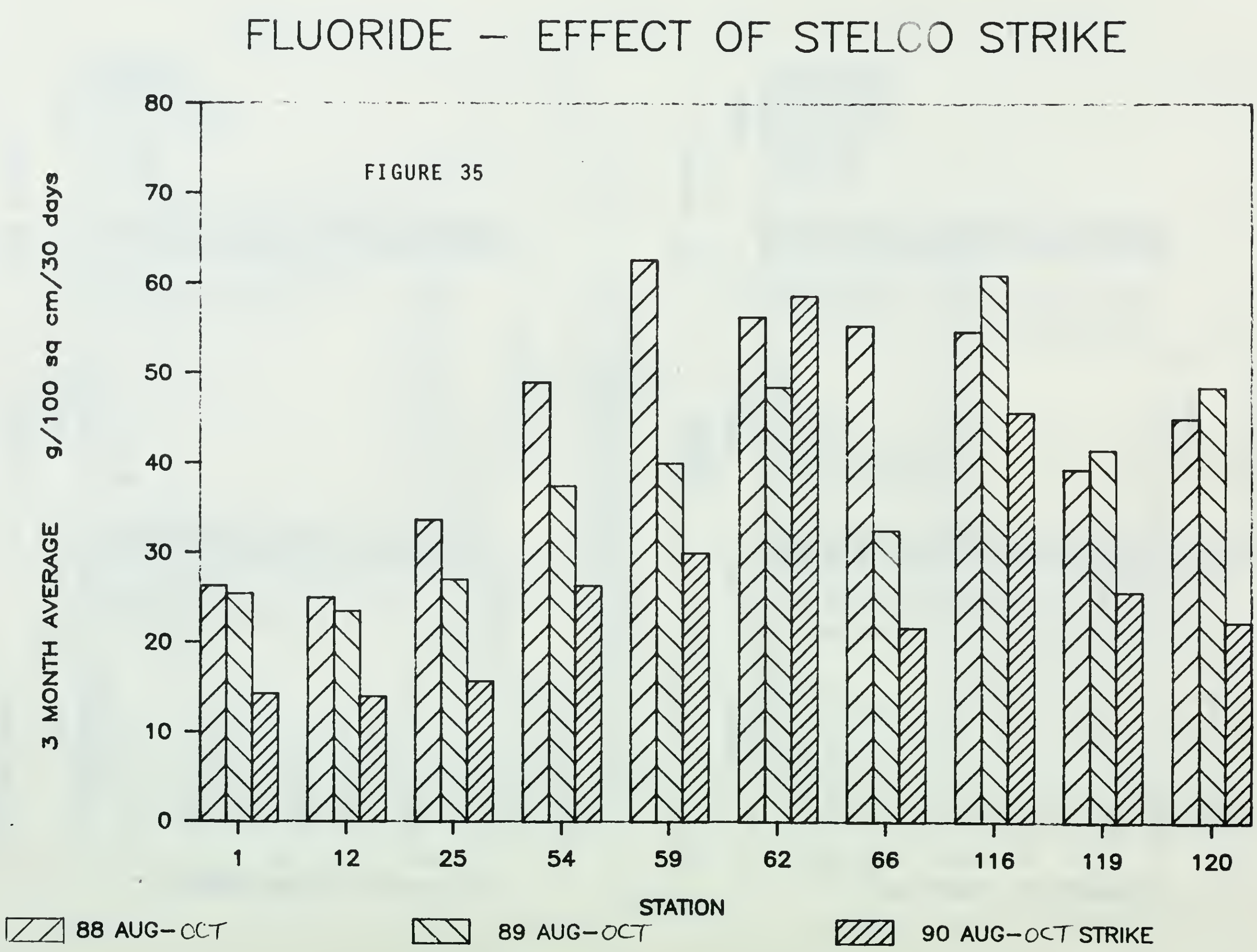
EFFECT OF STELCO STRIKE



MANGANESE IN DUSTFALL

EFFECT OF STELCO STRIKE




FLUORIDE – EFFECT OF STELCO STRIKE
FIGURE 35
3 MONTH AVERAGE g/100 sq cm/30 days
0
10
20
30
40
50
60
70
80
1
12
25
54
59
62
66
116
119
120
STATION
88 AUG-OCT
89 AUG-OCT
90 AUG-OCT STRIKE